AMERICAN MACHINIST

August 21, 1940

Vital—*Daily more important, the working of aluminum plays a vital part in defending this craftsman's country*

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HARRISON

HARRISON RADIATOR DIVISION
GENERAL MOTORS CORPORATION

LOCKPORT NEW YORK

July 24, 1940

American Machinist
330 West 42nd Street
New York, New York

ATTENTION: Mr. Burnham Finney, Editor

Gentlemen:

With reference to your letter of July 19th, I am quite satisfied with the American Machinist the way it is written. I am interested in all mechanical processes and progress, whether or not I can use the information directly in my work.

I probably get the most direct use out of the advertising and the descriptions of new machinery and equipment.

Yours truly,

HARRISON RADIATOR DIVISION
GENERAL MOTORS CORPORATION

Leo C. Shippy
Tool Superintendent

LCS:CMR

RADIATORS HEAT EXCHANGERS OIL TEMPERATURE REGULATORS THERMOSTATS HEATERS

WHAT'S IN THIS ISSUE

ALUMINUM AGE?

"Why don't they make it out of aluminum?" All through school, while we were under the delusion we would soon show Detroit how to make automobiles, we asked ourself that question. The thought of lugging around dead weight in everything from vacuum cleaners to box cars made our blood boil. Sheer waste, that's what it was. Sheer waste.

Since then we have been happy to note the increasing use of lightweight materials for all kinds of moving equipment. Foremost among these, of course, are the aluminum alloys. Thus it is with real enthusiasm that we recommend the special blue section in this issue. It has been compiled by Mr. Ben C. Brosheer, who, you may recall, was responsible for our special section of the working of magnesium last May. He must have kept going on his own momentum, for before the reprints were dry he was half-way through another on aluminum. This one, which begins on page 617, is really his masterpiece. It's the biggest we've ever published, comprising sixteen pages jammed with all the data, recommendations and specifications the average metal-working firm is ever apt to need. But we realize only too well how many aluminum products are going into aircraft manufacture, so Mr. Brosheer's kept his eye on the aircraft industry in writing the text.

MORE ON MILLING

On page 603 is an article which, it seems to us, no progressive production man can afford to miss. It's one of those detailed accounts that are packed with just the kind of information shop men can use. The subject of this particular one is the grinding of carbide milling cutters. It's the first of two articles by Fred W. Lucht, of Carboloy, on this important subject. In this one Mr. Lucht lays down the fundamentals, in the second he gives more specific recommendations.

BACK TO BATTLE

Seems like we just can't keep our mind off this war. That's propaganda for you. It's also the result of looking over proofs of the article on page 606, which is the second on how Republic Aviation boosts production with its as-many-jigs-as-possible philosophy. Both articles are by Hans Lasker, Republic's chief tool engineer, who came to Farmingdale by way of Switzerland, Germany and France. He has worked for Chance-Vought, Bird, United, Seversky and Republic. He's been organizer, researcher, estimator, assistant plant manager and chief tool engineer. Which should make him eligible for membership in the A.S.T.E.

HANS LASKER

PERSONAL INTEREST

We've long had a secret admiration for Monarch Machine Tool, what with its various employee-relations policies and activities. Unlike many firms that talk a lot and do little, Monarch really digs down into its pants pockets to smooth the way for its workers. So it's with a somewhat restored faith in human nature that we present D. H. McKellar's story on page 605. Mr. McKellar is Monarch's director of training, and we think you'll be interested in what he has to say about the personal interest Monarch takes in its men.

D. H. McKELLAR

WHAT, AGAIN?

Yes, again. Short Cuts for the Small Shop, by A. H. Waychoff. So popular has this feature become that the powers that be are considering making it a regular department. If you're in favor, use the back of a broken hacksaw blade to let us know. This issue's batch is on page 611.

AND MORE ON MEASUREMENT

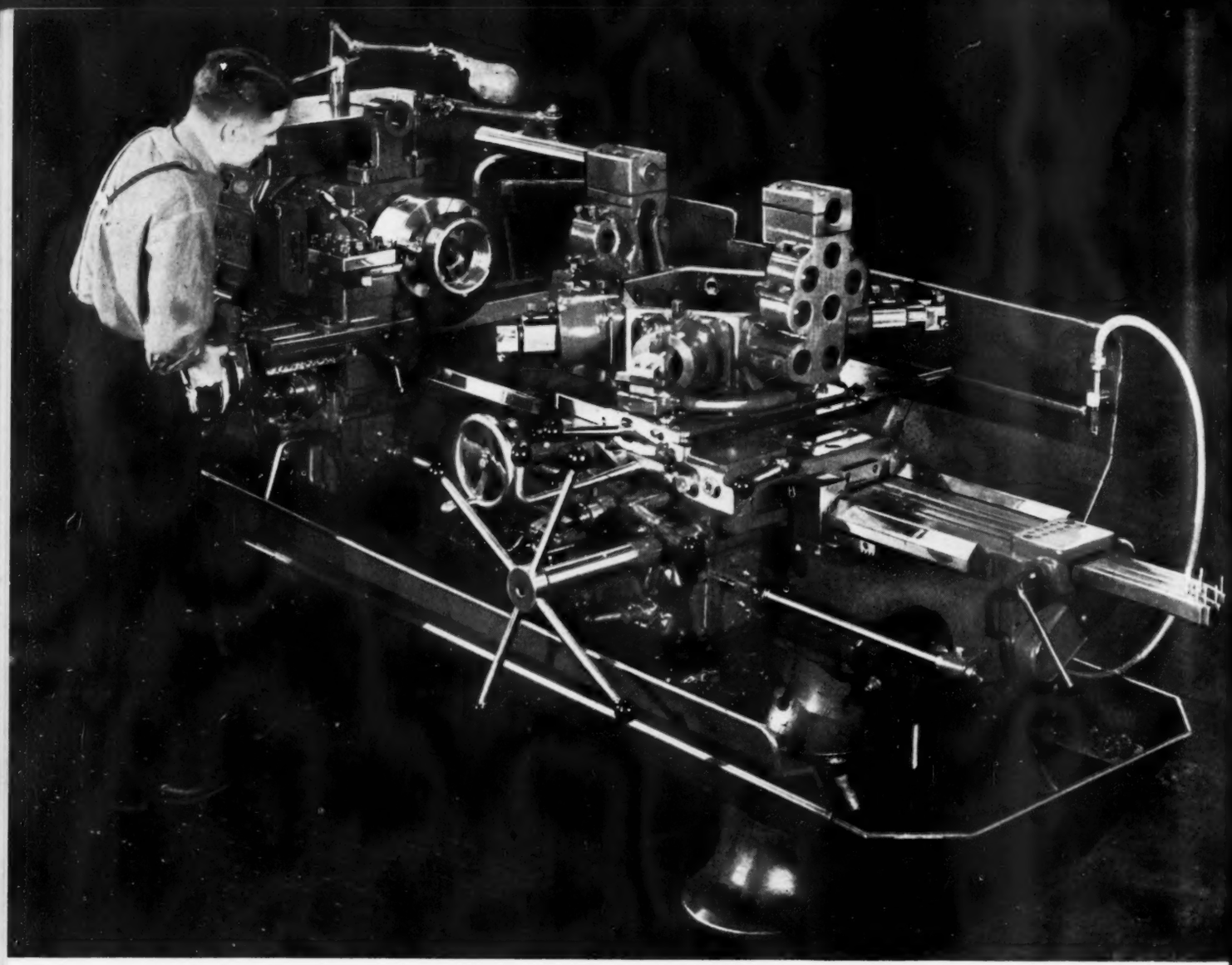
Last issue, you remember, C. C. Street of Federal Products Corporation discussed the fundamentals of measuring, in preparation for an exhaustive series on comparison measurement. This installment, on page 612, takes up where the last one left off, as you may suspect.

KNOCKOUT

For some time we've had the unofficial title of headline thinker-upper, the idea being to concoct headlines which would stimulate reading and still make sense. It's quite a problem—when you're stumped, even eight beers are no good. But we managed to create (!) one for Herbert Chase's article on page 616 which everyone in the office approved. We hope you will too. If not, write your criticism on the other side of that hacksaw blade.

COMING

You've read a lot about the way various companies make shells. But, so far as we know, there's been precious little published telling how to do the job yourself. So it is with considerable pride that we announce an article on how to make 75-mm. shells, which is scheduled for an early issue. Based on Frankford Arsenal's experience, it will comprise twelve pages telling how the job is done, including details of the tooling used.



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...CINCINNATI, OHIO.

ESTABLISHED 1877 **AMERICAN MACHINIST** BURNHAM FINNEY, Editor

Grinding carbide cutters

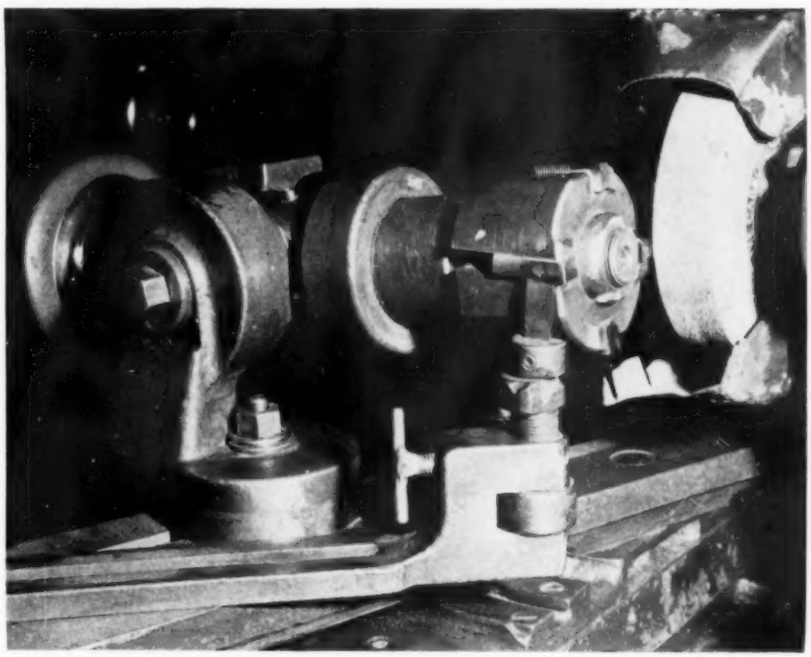
BY FRED W. LUCHT, ENGINEER, CARBOLOY COMPANY

I—No milling cutter can be expected to produce a good milled surface unless it is ground to the proper cutting angles and then kept sharp

A HIGH-QUALITY milled surface may be obtained only when the milling cutter is accurately ground. The technique for grinding milling and other multi-bladed cutters is simple and can be followed easily when thoroughly understood. Of particular importance when grinding cutters tipped with one of the cemented carbides, the following suggestions are equally applicable when the cutting edge is made up of some other material.

A milling cutter should never be used after it ceases to cut freely, because it consumes increasingly more power, produces inferior finish, and ultimately will cease to produce parts of the required accuracy. It is false economy to permit the cutter to become dull to the extent that a heavy grind is necessary for sharpening. More time is required to resharpen a very dull cutter than one that is only slightly dull; furthermore considerable carbide stock is wasted when resharpening a very dull cutter.

Major factors which must be considered when sharpening any milling cutters are: the assignment of a trained operator, supplied with complete instructions; the use of the correct type of grinding machine; the use of a tooth rest that can be adjusted accurately; and the use of correct grinding wheels.



Size and placement of the tooth rest depends on the type of machine used, size of the milling cutter, tooth spacing, and rake angle of the cutter

Two types of grinding machines suitable for sharpening milling cutters are available today. In the first of these, the cutter is mounted on the table and is moved past the grinding wheel head which, in turn, may be set in the desired position. The face of the tooth being sharpened is held against the tooth rest mounted on the table. In the second type of grinder, the cutter is mounted on a stud and the grinding wheel and tooth rest slide past the cutter. The face of the tooth being sharpened is held against the tooth rest mounted on the wheel slide, and the cutter is allowed to rotate as the tooth follows the rest.

The cutter grinder must be kept in first-class condition, with a free-running, snug spindle, gibs must be snug and the ways must be straight and true. For best results, the face of the cutter adapter on the grinder should be ground in position and, if removed for any reason, should be reground in position before using.

The ideal grinding cycle for reconditioning a cutter requires the following types of wheels:

1. A silicon-carbide, plain wheel of

about 80 grit (like Carborundum G-80 RW or Norton 3480-I7) is used for the rough cylindrical grinding of the carbide and steel on the periphery, chamfer and side of the tooth. Wheel speed for this operation, and for those which follow, will range from 2,700 to 5,500 ft. per min. Wheel in-feed per pass for this rough cylindrical grinding operation should be about 0.002 in.

2. A 60 grit silicon-carbide cup wheel (like Carborundum G-60 RW or Norton 3460-I7) with a 20 deg. beveled face is used for the rough back-off grinding of the carbide and steel on the periphery, chamfer and side of the cutter tooth. As in the first operation, a wheel in-feed of 0.002 in. per pass is satisfactory for most jobs.

3. A 120 grit silicon-carbon cup wheel (like Carborundum G-120 SW

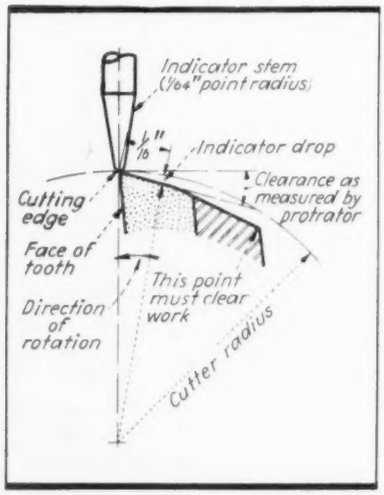


Fig. 1—When clearance angle is determined by a protractor the heel of the tooth often will rub the work—best practice is to measure the indicator drop $\frac{1}{16}$ in. back of the cutting edge

or Norton 34120-H7) may be used for finish grinding on the carbide tip only, where the finish on the part to be milled does not have to be held to an extremely fine surface. To prevent overheating of the carbide tips, the silicon-carbide wheel should have a 20 deg. bevel up to a $\frac{1}{16}$ in. wide face. Wheel in-feed per pass for the finish back-off operation on the carbide tip should be about 0.0003 to 0.0005 in.

4. A 220 grit, resinoid-bonded diamond wheel of the 20 deg. flaring cup type may be used for finish grinding the carbide tip only, where the finish on the part must be very smooth. In order to keep the run-out on the periphery of the diamond wheel within 0.0005 in. it is recommended that the wheel be mounted on an adapter and not removed from the adapter until worn out. In this way the diamond wheel can be mounted on the spindle quickly, and will maintain its true-running characteristic. A wheel in-feed of 0.0003 in. to 0.0005 in. per pass also is recommended for this operation.

The cutter should be fed across the grinding wheel by hand, as it gives the operator the feel of the wheel cutting at all times. Machine feeding is not recommended. The hand feed should be steady, and a rate of approximately $\frac{1}{4}$ in. per sec. Bond and hardness of wheel are important in each of the operations listed above.

In order to maintain a constant clearance angle behind the cutting edge, a tooth rest should be used to guide the grinding wheel along the cutter tooth or the cutter tooth along the wheel, depending on the type of machine used. The tooth rest should be made of hardened steel and should have a rigid cross-section. The size and shape of the rest depends entirely on the tooth spacing and the rake angle of the cutter. It should be arranged to give rigid support to the cutter.

The point of contact of the tooth rest should always be on the face of the tooth being sharpened. Clearance between the grinding wheel and the tooth rest should not be greater than $\frac{1}{32}$ in. The tooth rest should project beyond the cutting edge on the periphery of the grinding wheel for the purpose of guiding the tooth up to the point where the grinding starts. The leading edge of the tooth rest must clear the face of the tooth just before the wheel begins to cut.

Table 1—CLEARANCE ON MILLING CUTTERS

(Expressed in Thousandths of an Inch Drop $\frac{1}{16}$ in. Behind Cutting Edge)

MATERIAL	*Suggested Clearance On Carbide* On Periphery	On Side of Tooth
Aluminum	0.008–0.009	0.005–0.0065
Brass & Bronze – Hard	0.005–0.006	0.003–0.004
Brass & Bronze — Soft	0.0055–0.0065	0.0035–0.0045
Cast Iron, Hard and Medium	0.005–0.006	0.003–0.004
Cast Iron, Soft; also Semi-Steel	0.0055–0.0065	0.0035–0.0045
Copper	0.008–0.009	0.0055–0.0065
Fiber	0.008–0.009	0.0055–0.0065
Malleable Iron – Hard	0.005–0.006	0.003–0.004
Malleable Iron – Medium Soft	0.0055–0.0065	0.0035–0.0045
Plastics	0.008–0.009	0.0055–0.0065
Rubber – Hard	0.008–0.009	0.0055–0.0065
Rubber – Medium	0.010–0.011	0.0065–0.0075
Steel – Carbon and Alloy	0.007–0.008	0.004–0.005
Steel–Cast	0.0055–0.0065	0.0035–0.0045
Zinc Alloy Die Castings	0.009–0.010	0.006–0.007

Note: Add 0.002–0,005 in. to the "On Periphery" values shown above to obtain "rough back-off" tooth rest setting in Table II (see the second part of this article).

Correct clearance angle back of the cutting edge on the blade is essential. Teeth with insufficient clearance will drag over the work, causing friction which will result in poor finish, slow cutting and rapid tool dulling. Too large a clearance will tend to produce chatter and will result in rapid tool wear.

When the clearance angle is measured by a protractor it often is found that the cutter has insufficient clearance, especially for cutters 3 in. in diameter or smaller. This results in rubbing and rapid breakdown of the cutting edge. The best way to obtain the correct cutting clearance is by measuring the indicator drop in thousandths of an inch $\frac{1}{16}$ in. behind the cutting edge, as shown in Fig. 1, instead of by taking a protractor reading.

Measurement of the clearance angle with an indicator does not mean that

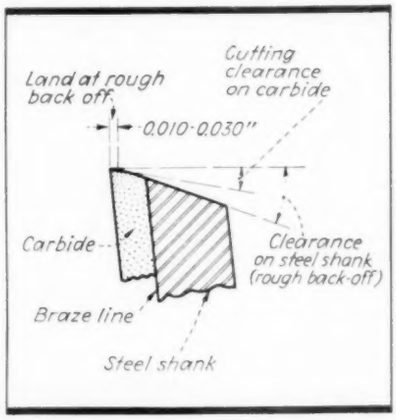


Fig. 2—Cutter tooth clearance angles produced by rough back-off and finish grinding operations are indicated above. For carbide-tipped blades, the clearance angle should run up to the cutting edge

the grinder set up is more complicated. Actually this method eliminates cut-and-try in the setting, and in the measurement of the clearance. Knowing the desired drop in $\frac{1}{16}$ in., as shown in Table I, it is necessary only to take this value and refer to Table II, which will be given in the second part of this article, from which is read the correct tooth rest setting to produce the desired clearance. Accurate results are obtained with this simple procedure.

The clearance angle is produced by properly locating the wheel, the cutter and the tooth rest. There are several methods of accomplishing this, depending upon the type of wheel used, the shape of the cutter and the location of the tooth rest. Taking these three factors into consideration, any experienced grinder hand can set up a grinding machine that will produce the desired clearance angles. In Fig. 2 are shown the elements of the milling cutter tooth and the angles produced when sharpening. The correct grinding procedure for carbide-tipped milling cutters will be discussed in part two of this article.

This plant didn't lose touch

BY D. H. McKELLAR, DIRECTOR OF TRAINING, MONARCH MACHINE TOOL COMPANY

Use of modern cafeteria and auditorium retains intimacy of small family at Monarch

WHEN WE EXPANDED our plant capacity last year, we included a modern cafeteria and an auditorium. From a strictly business standpoint, they weren't needed. But we felt that they would help in retaining among our employees the intimacy of a small family. Through their use Monarch would be fulfilling its family and community obligations.

Through many years Monarch has had a closely knit organization. The titleless office doors were open to employees, wives, merchants, teachers, city officials, social leaders. The result was a healthy relationship between the company and employees and between the company and the various members of the community.

At one end of the cafeteria employees can read the newspaper and listen to the radio

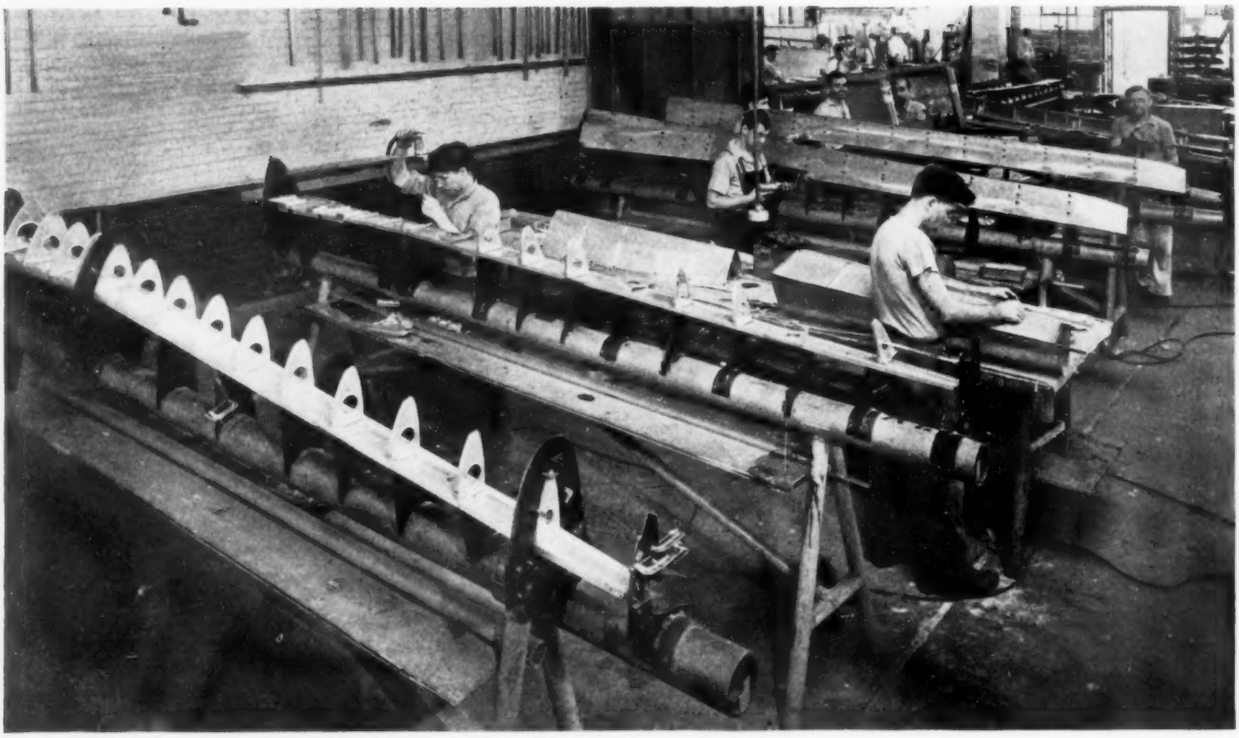
Employee departmental groups like to have card parties in the auditorium

We felt that as the company grew, it might lose that fine relationship unless measures were taken to prevent it. Unfortunately, as the number of employees grows, the natural tendency is for the men to be less acquainted with each other and to regard the company as merely a place to earn their bread.

Use of the cafeteria and auditorium, we felt, would offset that tendency. It would bring the employees closer to each other and closer to the management; and, after all, everyone in Monarch has a vital interest in a common enterprise.

Employees use the cafeteria and auditorium for a wide range of activities—ordinary lunch-time recreation, organized dramatic and musical entertainment, educational exhibits, special training courses. These facilities also are offered to various worthy civic, educational, cultural and charitable groups. No charge is made. The demand is so great that rules have been laid down governing use of the cafeteria and auditorium. Among these rules are the following:

Needs of the employees take precedence over those of public groups. No intoxicating beverages may be consumed, all games must be of the non-gambling type, all functions must be free from religious doctrine or political flavor. Admission may be charged only for activities for charitable purposes; no individual or group of individuals shall get any profit. Those who wish to use the facilities must apply to the management in writing, the management reserving the sole right to grant the privilege.



Leading wing edges are jig assembled from spars, press-formed nose ribs and templet cut skin. The ribs are lined up vertically by taut wires

Jigs for airplane assembly

BY H. LASKER, CHIEF TOOL ENGINEER, REPUBLIC AVIATION CORPORATION

II—Jigs designed to assure duplication of small and large sub-assemblies simplify later assembly operations. This is the basis of fast production

JIGS FOR ALL plane assemblies—simple structural parts, entire fuselage and wing sections, and complete planes—is one way to speed production. The Republic Aviation Corporation has put this into effect. The more jigs used for each part, the more men can be employed. And the more men employed, the more planes can be made in a given time. Under this plan, Republic achieves many of the mass-production features of the automobile industry.

Each Republic plane is divided during manufacture into fuselage and wing groups. The parts of each group constitute a major sub-assembly—front, middle and tail sections for the fuselage, and center, outer left-hand and outer right-hand panels for the wings. These are built up from minor sub-assemblies, such as spars, ribs, bulkhead or frame rings, longerons, stiffening ties, leading and trailing wing edges, wing tips, flooring, stringers and skin. (*AM*—Vol. 84, page 570.) These minor sub-assemblies are made in accurate jigs, and are so drilled and formed that they match within close limits during assembly of the major plane sections.

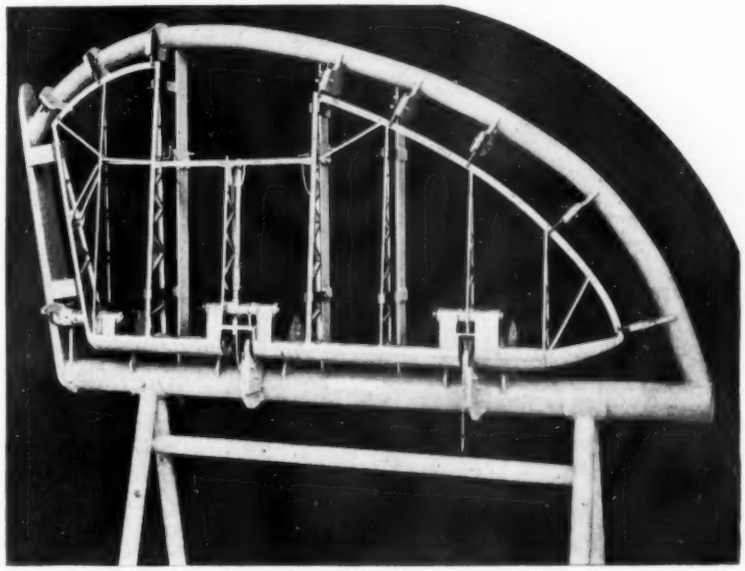
Outstanding features of the jigs are the small number of fastening points required, and the use of bolts and dowels to hold parts during assembly. Since assembly men have only to handle these bolts and dowels to remove a completed assembly from its jig, all assemblies from each jig are identical. This being characteristic of all jigs, progressive assembly of both minor and major sub-assemblies proceeds at maximum speed.

The jigs are built and maintained by expert toolmakers. Men employed on the production lines are trained quickly in the technique of their use.

Aside from component parts of major sub-assemblies, jigs are used to make canopies, turtledecks, air scoops, control surfaces, landing gear fairing, fillets, engine mounts, cowling parts, firewalls, instrument panels and covers. Also oil tanks, brackets of all kinds, seats, ammunition boxes and other accessories. Material for these parts may be press formed, stretched, hand formed and otherwise worked, following general sheet-metal practice for plane parts. Highly stressed parts are heat-treated. Landing gear parts and brackets of all kinds are machined from either forgings or solid metal.

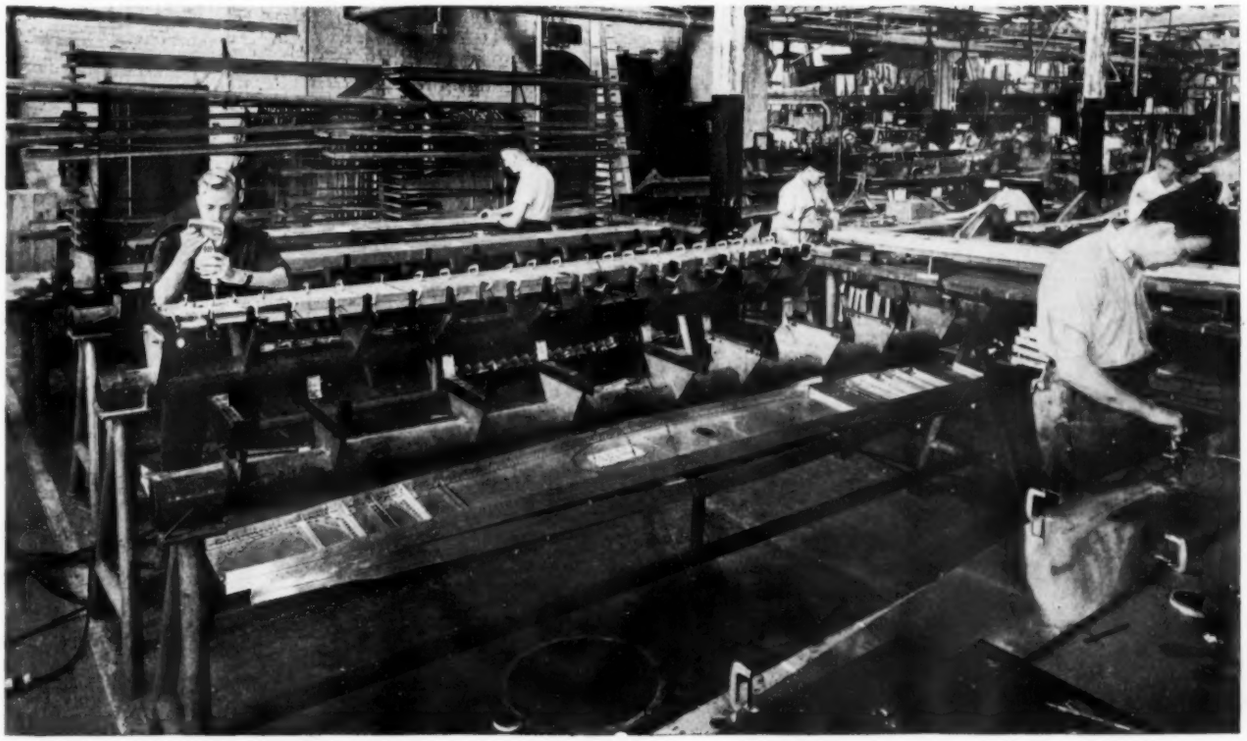
When these parts are completed,

Wing tips are assembled quickly and accurately in these jigs. The brackets on the upper curved member hold the contoured skin sheets for drilling and riveting to the ribs and spars. Pick-up holes for preliminary fastening are jig drilled at the splice end of the skin sheets



This rudder jig shows the technique of Republic's assembly practice. It is successful because the jigs are designed to assure exact duplication of sub-assemblies

Wing spars are assembled in these jigs which position a built-up web between top and bottom flanges. Bottom flanges, rib angles and the web are drilled through holes previously jig drilled in the top flanges and angles



they move to the assembly line. The line begins when a center wing panel is attached to a fuselage and the two parts mounted on a rolling jig with attaching points at the center panel and the tail. This jig is rolled from station to station when the outer wing panels, power plant, landing gear, tail surfaces, ailerons, flaps, cowling and all appurtenances and appliances are installed.

Accuracy of Sub-Assemblies

The success of the assembly line method here described depends on the accuracy of jig-assembled parts. This accuracy is maintained from the moment flat stock and angles for minor sub-assemblies are obtained from the stockroom.

Flat stock for ribs, spars, bulkhead rings, flooring, wing parts and skin sections are first sheared to approximate rectangular shape. A templet, which serves as a contour and drill jig, is clamped over six to ten flat sheets. Preliminary fastening holes are drilled, bolts inserted and the clamps removed. Following the contour of the templet, the sheets are rough cut to shape on metal band saws. Final contouring is done on vertical routers, the cutter following its guiding roller which bears against the side of the templet. Additional holes are drilled for preliminary fastening points during first assembly operations.

Some of the sheets are sent to assembly jigs without further work. Other sheets are flanged, pressed, stamped and otherwise prepared for later assemblies. The usual bending brakes, presses, nibblers, joggle presses, and draw-bench rolls are employed.

Extruded angles are cut to desired lengths and drilled accurately in jigs. When required, angles are rolled and drawn to match the curved lines of the ship, the contour being held to close limits by templets. Offsets are made on joggle presses.

The technique of jig work is best exemplified by assembly methods for spars, bulkhead rings, leading and trailing wing edges, wing tips, wing flaps, rudders and longerons. Jigs for these parts are illustrated.

Take the spars, five of which run longitudinally through each wing panel. The work done on No. 1 spar for the center panel is typical of all spar assemblies.

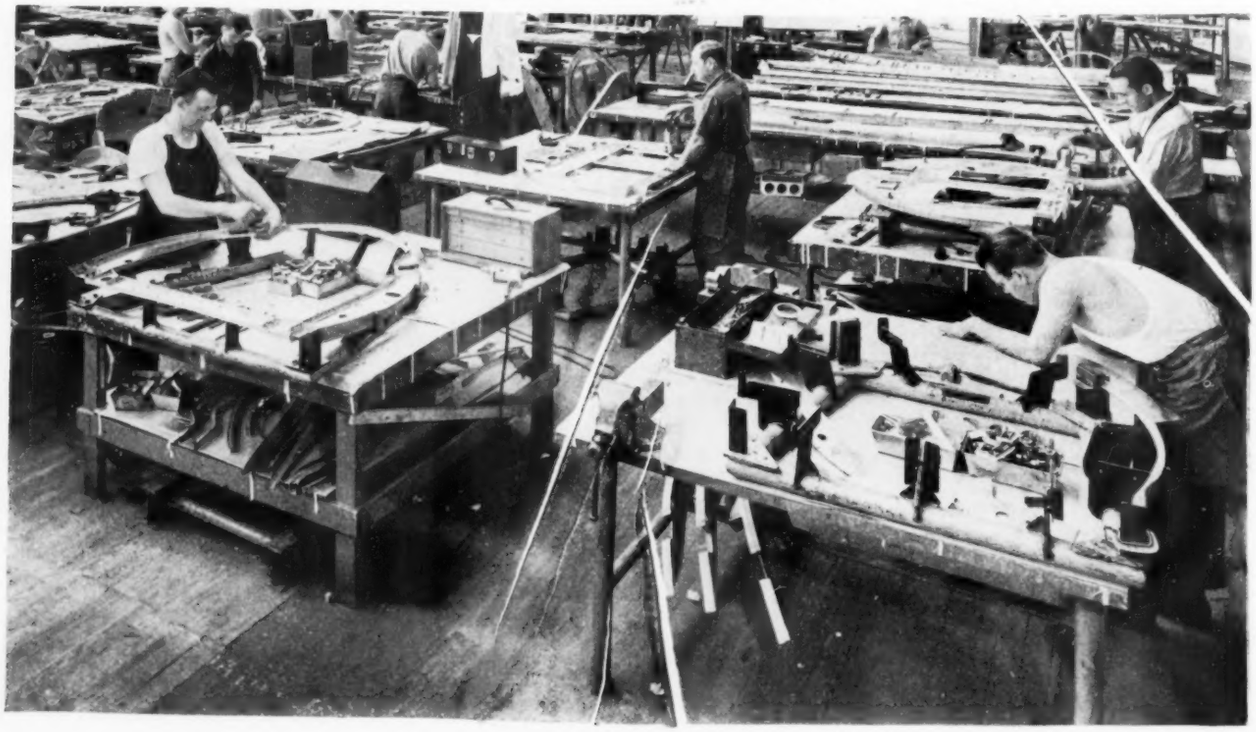
The web is built up from flat plates of various lengths. One center plate runs the length of the spar, while shorter ones are used at the ends for stiffeners. These plates, previously routed to exact shape, are clamped together. Holes drilled in the top plates serve as guides for drilling the web assembly. When drilled, the clamps are removed and chips are blown from between the plates. They are then temporarily bolted together, all holes are reamed preparatory to riveting, and the bolts loosened to remove chips. When the bolts are retightened, the plates are riveted. Only the holes necessary for assembly of the web plates are drilled and reamed at this time. Those for top and bottom flanges and rib-attaching angles are drilled in the jig when assembled to the web.

No dowels or fastening bolts are used on the spar jigs. Rather the top and bottom flanges with the web between them are clamped to accurately spaced brackets so machined that the flanges and web fit snugly therein prior to clamping. When clamped, the bottom flange and web are drilled through holes in the top flange, previously jig drilled for this purpose. Stiffener and rib-attaching angles on both sides of the web are bolted in place and drilled through holes in the top angles; two holes were previously jig drilled in the bottom angles for the fastening bolts. When all holes are drilled and reamed, the fastening bolts are loosened, chips are removed, the bolts tightened, and the parts spot riveted together. The spars are removed from the jigs and machine riveted. Later they are replaced in the jig, inspected, and forged corner brackets are applied.

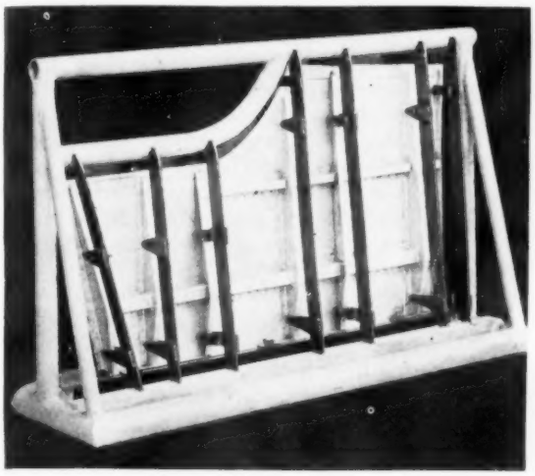
Jigs Simplify Assembly

Bulkhead or frame rings are assembled in much the same manner as spars. The jigs, made of tubular sections with attaching plates and brackets welded in place, are set flat on work benches. The brackets require no bolts or dowels to hold ring

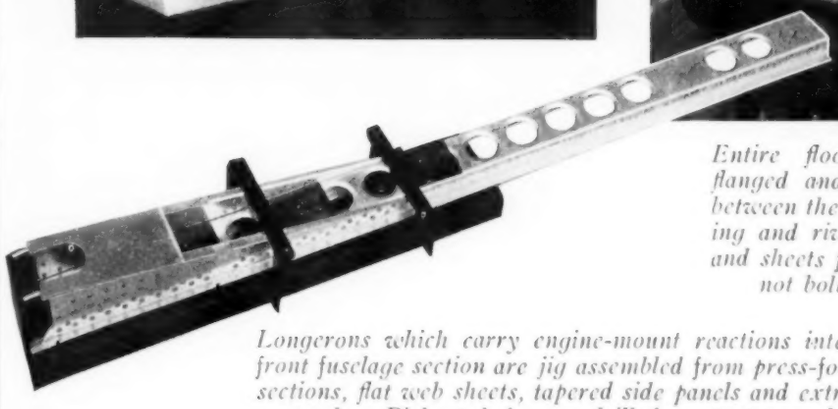
Bulkhead rings are assembled from circular flange sections set in attaching brackets around the perimeter of their jigs. Web sections and stiffening angles are bolted in place for drilling, reaming and spot riveting. The jigs are used for inspection after machine riveting the assembly



These wing-flap jigs are typical of Republic's policy to make all parts of the sub-assemblies easily accessible for drilling and riveting. The attaching points are designed to require minimum handling and no adjustment



Entire floor sections are made from corrugated, flanged and press-formed sheets. These are placed between the angle frames of the jig preparatory to drilling and riveting flanges and stiffeners. The flanges and sheets fit snugly between the angle frames and are not bolted or clamped thereto during assembly



Longerons which carry engine-mount reactions into the front fuselage section are jig assembled from press-formed sections, flat web sheets, tapered side panels and extruded angles. Pick-up holes are drilled to start assembly

sub-assemblies, since the brackets are machined to the shape of the sub-assemblies; however, during preliminary assembly, the parts are clamped to the brackets.

The rings are built up from web sheets placed between flanges and stiffeners; however, some of the rings have but one flange. The flanges, semi-circular in shape to conform to the ship's lines, are rolled in sections of various lengths. These are assembled around the perimeter of the jig and clamped in place. The web sections, flanges and stiffeners are temporarily bolted in position through pick-up holes jig drilled previously. Complete drilling is done in the jig through the top flanges and stiffeners, holes in which were drilled before they were shaped. Before machine riveting the ring assembly, all holes are reamed, chips and burrs removed, and spot rivets are applied.

Leading wing edges are assembled by placing a spar in a jig formed by a horizontal steel tube to which are welded accurately spaced attaching brackets. With the spar resting in the brackets, rib-attaching angles are applied to the top of the spar. Nose ribs are drilled through the angles and riveted after being lined up vertically by taut guide wires running through jig members around two end and one center rib. This assembly is shown in one of the illustrations. The skin is bent around the nose ribs, drilled through the rib flanges, and removed for dimpling to take flush rivets. When replaced over the ribs, the skin is held by spring fasteners preparatory to riveting.

Trailing edges are jig assembled in the same manner as leading edges. The jigs are horizontal steel tubes supported by triangular legs imbedded in concrete. Attaching points are spaced to hold rib-attaching angles, aileron brackets and flap brackets, all of which are riveted to the spar. Ribs, stiffeners, ties and stringers are assembled in order and drilled and riveted as they are assembled. The skin is drilled, removed for dimpling, replaced, held by spring fasteners, and finally riveted. The jigs for the trailing edges, with both flap and aileron openings, are open and accessible at all stages of assembly.

Wing tips are assembled in jigs with fastening brackets around the edges and angle irons at the outer-panel splice. The brackets are welded to a steel tube curved to match the curved end of the wing tip. This tube in turn is welded to a large tubular section supported by triangular legs. Welded to the horizontal member are rounded and tapered angle irons which conform to the shape of the wing section. During assembly, the top skin, ribs and bottom skin are applied, each being drilled and riveted in turn; however, the skin is dimpled for flush riveting before final assembly.

The foregoing description of jig-assembled parts applies in general to assembly of longerons, flaps, rudders and flooring, illustrations of which are shown. The rudder jig in particular shows the technique of Republic's assembly practice. In every instance, the jigs are designed accurately to assure exact duplication of sub-assemblies. The success of Republic's jig-assembly methods is predicated on this fact.

"Learners" trained soundly

Master simple jobs in 12 weeks, develop into specialists in 18 months. Plan can be widely used

THE TRICK of training men soundly for a job in the shortest possible time is something that hundreds of metal-working companies are learning. It is a technique which works. Nowhere has it worked better than at a company in Cincinnati, Ohio, which has taken 1,000 "green hands" the past three years and trained them in a matter of weeks to do a good job. This "learner" plan is adaptable to almost any metal-working plant.

Trainees go through three stages: (1) the theoretical or "tell 'em" stage, (2) the practical application of the "tell 'em" through the "show 'em" demonstration on the machine, and (3) the "do it" stage where the trainee actually does the work.

Applicants for the course are confined to the age group between 18 and 21 years. The company prefers to take boys who have graduated from either a mechanical or academic high school. In fact, over 90 per cent of the boys selected are high school graduates.

The prospective trainee fills out and files an application giving his history. He has a talk in the employment office with one of the interviewing clerks, after which a careful check of his references is made by phone. If he appears to be desirable material, he is interviewed by an assistant superintendent who has charge of the department where he will be assigned to work.

Upon approval by the assistant superintendent, the trainee is given a physical examination and told when and where to report. Arriving at the shop the first day, he goes immediately to the safety department for instruction in safety and plant policies. He is assigned a locker and introduced to the foreman for whom he will work.

The foreman gives him an outline of the work being done in the department and in turn introduces him to the machine operator whom he will serve as a helper for the following two weeks. During his period as a helper, the trainee handles both finished and unfinished parts, has a chance to watch carefully the work being done on the particular machine, and is encouraged to ask questions about the machine.

At the end of two weeks the trainee is assigned to a machine which he operates on simple jobs with constant supervision. As time progresses, he needs less and less watching. After twelve weeks have passed, he is ready to do more difficult and complicated work.

The machine training is supplemented by courses conducted after working hours under the supervision of the vocational department of the Cincinnati Board of Education. The trainee receives instruction in blue print reading, shop mathematics, and shop theory and practice. Text books of the Ford Training School are used. Class attendance is voluntary.

A sliding scale of wages is provided by age groups. The starting rate at the age of 18 is 35 cents, at 19 it is 40 cents, and at 20 and over it is 50 cents. No matter what the starting rate, an increase of 5 cents an hour is provided every six months until the standard rate is reached.

Abstracted from **Industrial Trends**, The Industrial Association, Cincinnati, Ohio.

Problem for Engineers

Dear Sir:

In the past few years there has been a re-appraisal of engineering training, with much discussion of what studies will contribute to the young engineer's professional development. Differences of opinion have appeared concerning the kind and amount of instruction the student should receive in certain subjects, but as regards fundamental objectives there has been substantial agreement. Conspicuous among the points unanimously accepted is that every engineering student should learn how to write a good report.

This, of course, is not a new objective, but a new emphasis on a phase of training long recognized as important. It gains added force because it is an insistent recommendation coming chiefly from experienced engineers and from executives who employ engineering talent. These men appreciate the need for report-writing ability, and they know definitely when a subordinate has or lacks it.

A timely and practical contribution to this phase of an engineer's preparation is *Writing the Technical Report*, which recently appeared. The author, Professor J. Raleigh Nelson, of the University of Michigan, not only recognizes the need but does something about it. Through analysis of typical examples and through suggestions concerning preliminary study, planning, composition and criticism of reports, he points the way to their intelligent and efficient preparation. Perhaps his greatest service is in making clear the nature and function of a technical report as distinguished from other forms of writing with which it may be confused.

A report, as the author points out, has a particular task to perform, or in engineering terms, a "specific load to carry." It summarizes the results of an investigation which has been undertaken for a definite purpose; this purpose determines the design or plan of the report. Its content consists not of general information but of facts which bear directly upon the question that the investigation was meant to answer. Moreover, these facts are to be presented so they will be most readily intelligible and most directly useful to those for whom the report is intended. Conclusive evidence of the writer's clearness of thinking and his singleness of purpose is found in the brief abstract which states the object of the report and summarizes its conclusions.

The preparation of a complete, well-planned report is vastly more than an academic exercise. It is a problem in thinking as well as writing. It is a means of clarifying the engineer's understanding of details in relation to the main issue. From the practical standpoint, it is an indispensable part of his training for professional success.

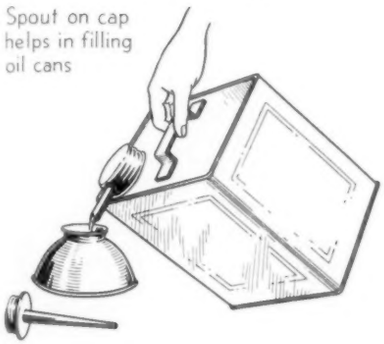
Very truly yours,

CLYDE W. PARK

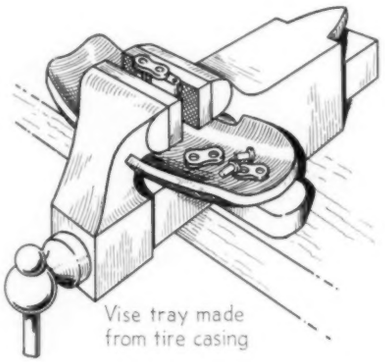
Professor of English, College of Engineering and Commerce, University of Cincinnati

Short Cuts for the Small Shop

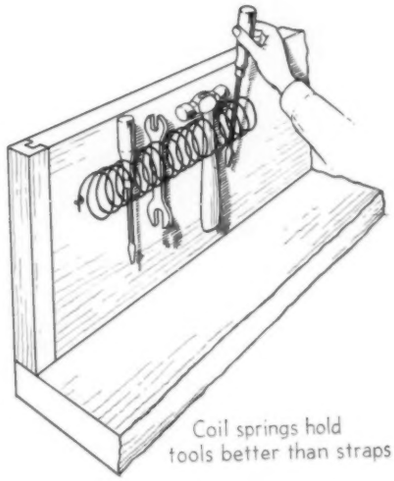
By A. H. WAYCHOFF



FIVE-GALLON CANS of oil can be poured into hand oilers with little trouble, using the idea shown. Screw the cap on tight and back it up about half a turn. Then drill a ¼-in. hole through both the cap and the neck. Get a piece of ¼-in. thin-wall tubing about four inches long and solder it onto the hole in the cap after flanging it a bit. When screwed tight the holes pass so there is no leakage, but on turning the cap the holes line up so the contents can readily be poured. This does away with all chances of dirt getting into the can and of spillage, loss or fire hazards. When the can is discarded, the cap may be saved and a hole drilled in the neck of the next can.

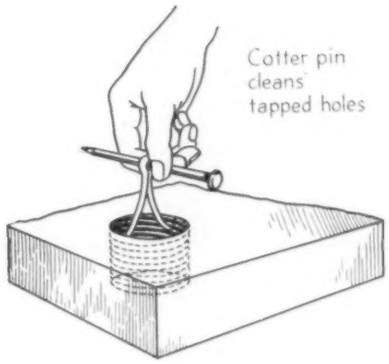


WORKING AT A VISE can be made lots more convenient with this simple little tray for holding small parts. Take a section of old auto casing and cut a couple of notches in the side so the vise can close in on it. The notches are fitted on the vise jaws and the vise may then be opened or closed without the tray interfering with it. Yet the tray is held rigid and stiff for catching any small parts. The notches should be deep enough so that the vise with the jaws completely tight will just fit in the slots, then the jaws may be opened up considerably with the slots still holding the tray in place.

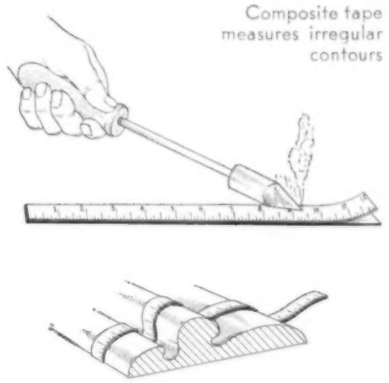


AS A RACK for holding small tools on the wall at the back of the bench, a few coil springs will be found better and handier than the usual straps. The springs should be slightly open, and attached to the wall with staples every so often. Small tools, such as wrenches, pliers, screwdrivers, etc., may then be placed in the rack by pushing them between any pair of coils. They are lots easier to take out and replace than with the usual straps, which always seem to be too tight to put a tool in and too loose to hold it after it is in.

FOR SHALLOW CUTTING with a hacksaw, this depth gage comes in mighty handy. There is nothing to do but cut out a shape about half an inch wide with two L-shaped ends being left about an inch and a half long. The over-all length should be a little less than the distance between the hacksaw blade holes. Then each end is given a return bend, and several ¼-in. holes drilled and tapped in one side of the bent part. Each end is fitted with a small thumbscrew. The gage can quickly be adjusted so the saw cuts anything from a tiny scratch up to about half an inch deep. That way slotting screw heads, duplicate cuts, grooving and fine rack cutting can be done easily and uniformly.



WHEN MACHINERY'S being overhauled, all threaded holes should be cleaned out properly. Few mechanics have the proper tools to do this, but a good job can always be done by using an ordinary cotter pin sprung out as shown. Just screwing it down the hole with a nail run through the eye cleans all grease and gum from the threads. That way the machine's easier to put back together, and a cleaner job is done.



A SWELL TAPE for measuring irregular objects can be made from an ordinary steel tape and a thin strip of lead. One machinist cut off about two feet of the tape, and cut a piece from sheet lead about a sixteenth of an inch thick and the same width and length as the tape. He cleaned both the back of the tape and one side of the lead with soldering acid and tinned them. Then he sweated the two together. This made a one-piece tape which could easily be bent into almost any shape. He uses it to measure all sorts of irregular shapes, and to transfer contours. Says it's better and simpler than any other gadget he's seen to do the same thing. When he's through, he just pulls it between his thumb and forefinger to straighten it out.

Comparison instruments

BY C. C. STREET, CHIEF ENGINEER, FEDERAL PRODUCTS CORPORATION

Optical and electrical units for comparison magnifying are generally more satisfactory in making precise measurements than are most mechanical units

COMPARISON INSTRUMENTS are distinct from direct-measuring instruments in that they contain within themselves no absolute standard. They do, of course, have a scale of a reasonable degree of precision for a short range to either side of some nominal zero point. The magnitude of this range is dictated by the purpose for which the instrument is made. The simplest of all such comparison or indicating instruments is the familiar "wiggler" which has been used by shop mechanics for many years to center a punch mark on a piece mounted on the faceplate of a lathe. This device has been improved from time to time and finally has taken the form of a simplified indicator operated by a series of multiplying levers. Some instruments of this type are offered commercially, one being the "Ideal" indicator which consists of two levers and a dial graduated to 0.001 in. over a range of approximately 0.010 in.

The next step in mechanical indicating devices is the gear driven dial indicator which is in common use today. The origin of this instrument is uncertain, but at some time during the early part of this century, two mechanics of the Waltham Watch Company built for their own use some dial indicators from various watch parts. These later were manufactured by the Waltham Watch Company for application on their measuring problems. At a later date these two men went into business for themselves and today are manufacturing dial indicators on a commercial basis.

The dial indicator has reached a high degree of perfection in its present form, and engineering principles indicate that there will not be a great deal of improvement in their various characteristics, because of inherent errors that always must exist, even to an extremely minute extent, in any fabricated metal part. There always will be periodic and cyclic errors in the accuracy of the readings indicated. In a gear driven dial indicator the geometry of gearing shows that two gears can never transfer velocity from one staff to another without periodic change in the torque delivered. This is due to the friction absorbed by the faces of the gear teeth. This friction various from some minimum to maximum value with each tooth cycle.

The general principle of a comparison indicator is to magnify faithfully a minute amount of motion until it can be read with an appreciable degree of ease. Since the greater the magnification used the greater will be the friction, in most instances, it is advisable never to use an instrument of higher magnification than required for the particular problem at hand. A reasonably good criterion of the magnification needed will be such that the instrument will indicate with a motion of approximately 0.050 in. the least unit that it is desired to read. An example of this might be the use of an instrument having the magnification of 50-to-1 when the precision desired is 0.001 in. It is often thought that the greater the magnification is the more accurate the measurement will be. This reasoning is as fallacious as that of a carpenter using a micrometer caliper graduated to 0.0001 in. for

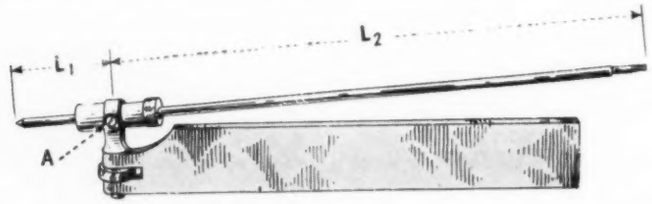


Fig. 1—The simplest form of indicator is the familiar "wiggler" used for many years to aid in centering parts on the faceplate of a lathe for precision boring

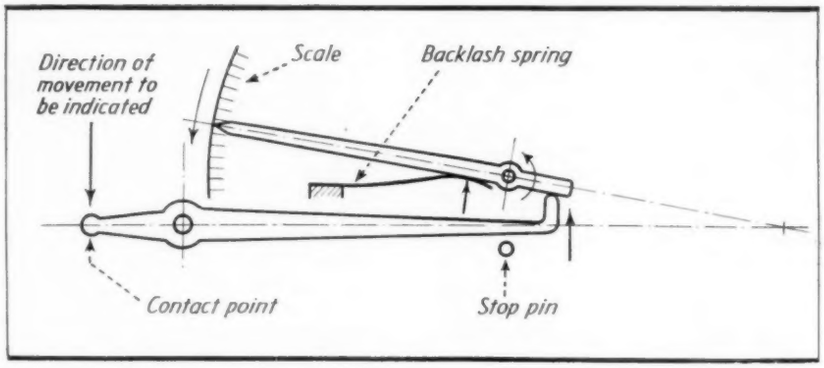


Fig. 2—By using a series of levers the over-all magnification of the "wiggler" is broken up in the well-known shop indicator. Reliable readings are possible at up to 50-to-1 magnification

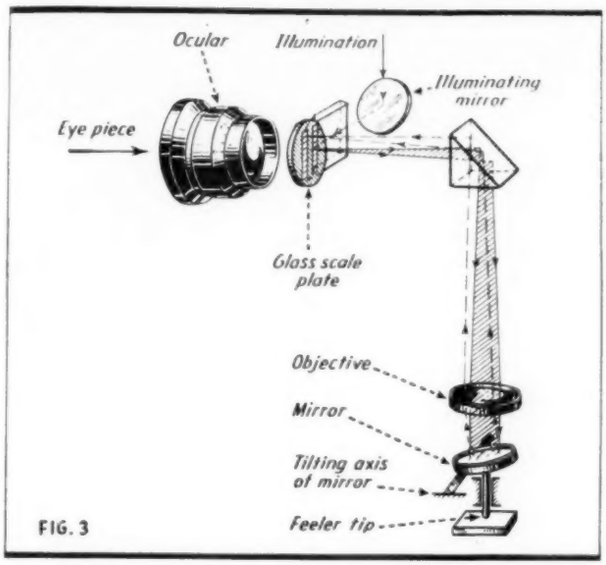


Fig. 3—This sketch shows principal parts and optical system of the high-magnification Zeiss optimeter. Both a reflected scale and a reference line are viewed through the eyepiece

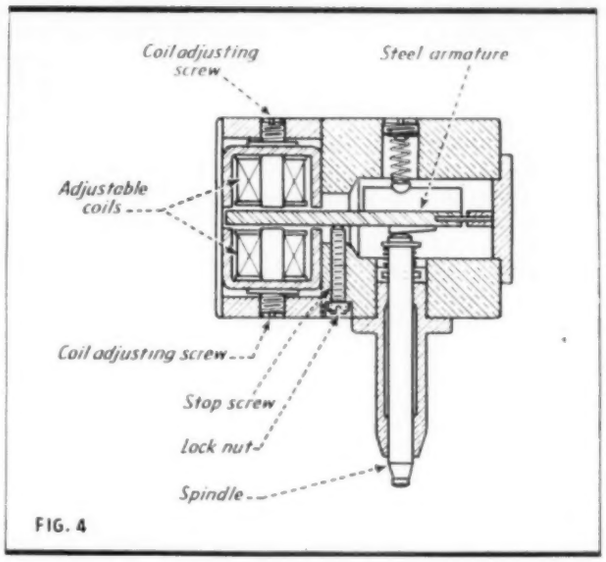
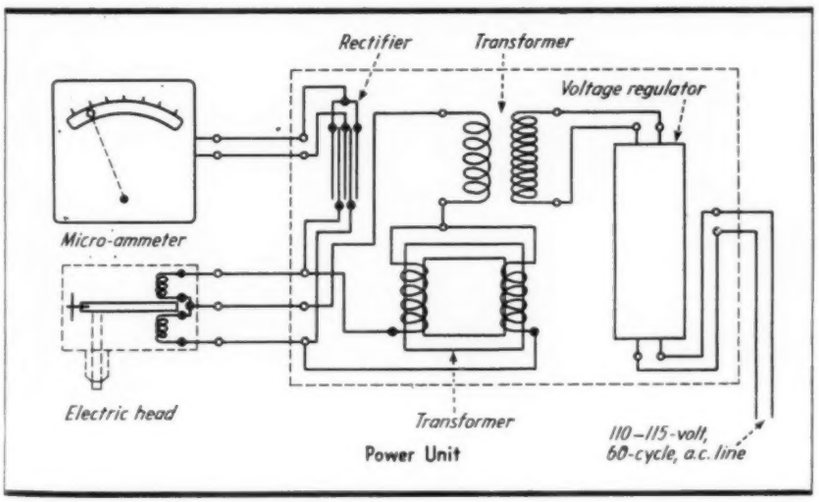


Fig. 4—Gagin head of Pratt & Whitney's electrolimit gage is arranged to alter the impedance of two magnetic coils when the spindle moves the steel armature up or down

measuring the thickness of his planed boards.

Many instruments of high magnification have been developed for special purposes, some of these are the Zeiss optimeter, the Pratt & Whitney electrolimit gage and the Sheffield reed comparator. These, for the most part, originally were developed for the comparison of master gages and size blocks. Later, due to the increased precision of production manufacture, these instruments have been used for routine inspection, particularly in the automotive and aircraft engine field.

The simplest form of indicator is shown in Fig. 1. It consists of a multiplying lever pivoted at point A. The amount of magnification is equal to the ratio of L_1 to L_2. The possible magnification to be obtained from such a device is definitely limited by the weight of the long pointer necessary to obtain a large value of L_2. The magnification can be increased by reducing L_1 to an extremely small value, but then the load placed upon the pivots becomes excessive and friction produces erroneous readings. The greatest possible satisfactory magnification that can be obtained is approximately 20-to-1, and if we use this previously mentioned 0.050 in. as the smallest readable motion, we would then have as the least unit to which this instrument can read 0.0025 in. This principle of magnifying levers can be improved upon by using extremely light members and breaking the over-all lever magnification into two separate units. Such a device is shown schematically in Fig. 2. It will



Head of the Zeiss optimeter can be mounted vertically, as shown, or horizontally for precision measurements—the least division on the scale of this instrument indicates a 0.00005 in. movement of the contact point

Fig. 5—Electrical circuit of the electrolimit gage is relatively simple. This instrument has given magnifications of 10,000-to-1 and higher on some applications

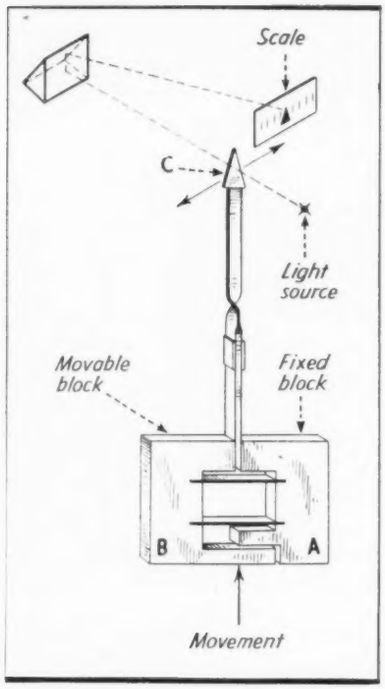


Fig. 6—Sheffield's reed comparator has two spring-connected blocks which move rectolinearly with respect to each other

be noted that this permits a lighter construction, and is capable of higher magnification with less pivot friction. An analysis of the forces exerted at the pivots will show the manner in which the improvement is obtained. Such an instrument as this can be used up to magnifications of 50-to-1, giving very reliable readings.

Dial indicators follow very generally the same pattern with most manufacturers, differing only in minor detail of design and method of assembly. They generally can be described as consisting of a rod running in two accurately reamed bushings, and having attached to it a pin fitted into a slotted guide so that this rod is free to move longitudinally but not to rotate axially. In the side of this rod are cut a series of rack teeth which mesh with a pinion, usually having from 16 to 40 teeth depending upon the magnification of the particular instrument. Mounted on the same staff with this pinion is a gear having a larger number of teeth, usually between 75 and 200 teeth. In the lower magnification instruments this gear meshes with a small pinion that is placed in the center of a circular dial, and to which the hand is fixed. Motion of the rack spindle causes this system of gears to revolve about their axis, and in this manner the hand passes over the graduated dial to indicate the amount the rod or rack-spindle has been moved.

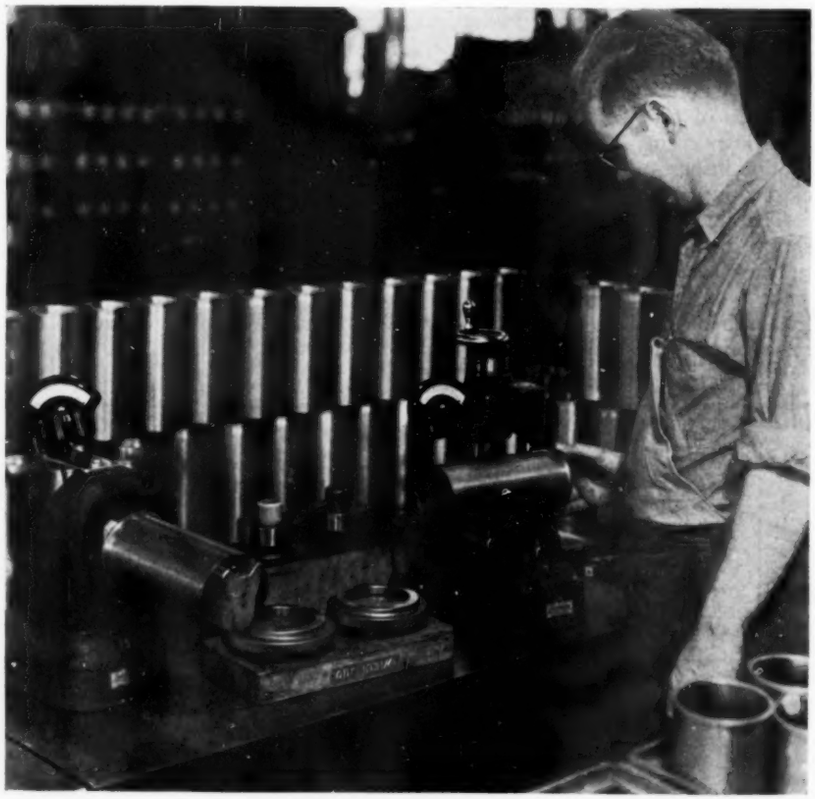
There usually is, in addition, some place in the system, another gear meshed with the center pinion and having attached to it a hair spring for the purpose of absorbing back-lash in the gear train. In instruments of high magnification, where one revolution of the hand is equal to 0.050 in. motion of the rack-spindle, there usually is interposed between the gear assembly that meshes with the rack-spindle and the center pinion another set of gears to obtain this higher magnification. A few instruments that are compounded to an even greater extent have been tried experimentally, but friction and inertia of the moving parts have made such devices highly impractical.

The highest gear ratios that have so far shown themselves to possess satisfactory characteristics are those giving one revolution of the indicating hand to a motion of the rack spindle of 0.010 in. By using a dial $3\frac{1}{4}$ in. in diameter, this gives a magnification of approximately 1,000-to-1.

The Zeiss optimeter is perhaps the most notable of the high magnification comparing instruments. It is optical in principle, and the major parts are shown schematically in Fig. 3. A small scale, photographically engraved on glass, is viewed through the eye-piece as a reflected image from a movable mirror. The mirror is mounted on knife edges so that a slight motion of the contact point causes it to tilt. There is in the focal plane of the eye-piece a fine reference line, and the lenses are so arranged that the scale is projected as an image at this focal plane. In this manner both the scale and the reference line can be viewed simultaneously through the eye lens.

The effect produced is such that as the mirror is tilted the scale appears to move, and the amount of motion of the contact point is determined by the division of the scale which appears opposite the reference line. The least division on the scale of this instrument corresponds to a movement of the contact point of 0.00005 in. The mirror mechanism is so arranged that the contact plunger operates under a pressure of approximately 8 oz. This instrument is an indicator in the pure sense of the word, and its most common application has been on a comparison stand, as shown.

One notable attempt to obtain high magnification with a simple mechan-



An advantage of the electrolimit gage made by Pratt & Whitney is the fact that the indicating meter can be placed in a position most convenient for the operator. The head also can be connected to a recorder

Magnifications as high as 10,000-to-1 are made satisfactorily with the reed comparator offered by Sheffield

ism is the Prestwitch fluid gauge manufactured in London by J. A. Prestwitch & Company. This consists of a flexible bellows chamber of rather large capacity, to which is attached a long glass tube. A contact point is integral with the lower half of the flexible chamber, so that a slight motion of the contact point displaces an appreciable amount of the fluid with which this chamber is filled. Since the only place the liquid can go is up the glass tube, it gives an indication of the motion of the contact point. The ratio of magnification is equal to the ratio of the area of the bellows chamber and the bore of the glass tube. Instruments possessing various magnifications between 500-to-1 and 1,200-to-1 have been made. Due to the fact that in many respects the instrument is similar to a thermometer, it is quite sensitive to temperature variations. Because of this effect, it has found but slight use in this country during the past ten to fifteen years.

Many electrical devices have been experimented with, but the only one that has shown practical commercial value to date is the Pratt & Whitney electrolimit gage. The principle of this unit is to alter the impedance of two magnetic coils by having a steel armature move between the ends of their cores. This instrument has given satisfactory magnifications of 10,000-to-1 and higher. Here, again, the electrical head of this instrument can be used as an indicator in a manner similar in most instances to the application of dial indicators, with the added advantage that the indicating meter can be placed in the most convenient position to be observed by the operator, or at a remote point up to distances of several hundred feet. Such a device can also be used to operate a recorder, so that a continuous and permanent record of the measurements obtained will be made automatically. The gaging head is shown in Fig. 4 and the electrical circuit in Fig. 5.

The Sheffield reed comparator operates on the novel principle of having two metal springs attached together at their ends as shown in Fig. 6. One spring is rigidly attached to block *A* with the other spring attached to block *B*. They are so mounted as to move rectolinearly with respect to each other. A motion of block *B* causes the two reed springs to move in an arc as shown by the arrow. An image of the pointer attached to the end of these springs is projected by lens *C* against a scale. In this manner magnification is obtained mechanically by the arc motion of the reed springs, and optically by the magnification of the objective lens *C*. Magnifications as high as 10,000-to-1 have been developed with this principle.

It can be seen from the foregoing that comparison instruments consist primarily of ingenious methods of magnifying minute motions. The attempt is always to obtain this motion with as frictionless a mechanism as possible. The optical and electrical methods approach this requirement to a far greater extent than the straightforward mechanical devices. In the final analysis, the usefulness of any indicating instrument is the precision with which it will repeat its readings under identical external conditions. As an example, assume an indicating device placed above an accurately lapped table, and a 1-in. size block placed between the table and the contact point. If, regardless of the speed or direction at which the block is passed under the contact point, it always indicates the same value, it would then be an ideal comparator. This condition is seldom realized, but in many of the higher quality instruments, the deviations caused by friction and erratic movements of the mechanism have been reduced to such an extent that such errors are hardly detectable.

The third article in this series by Mr. Street will appear in an early issue.

Connecting Rod Contours

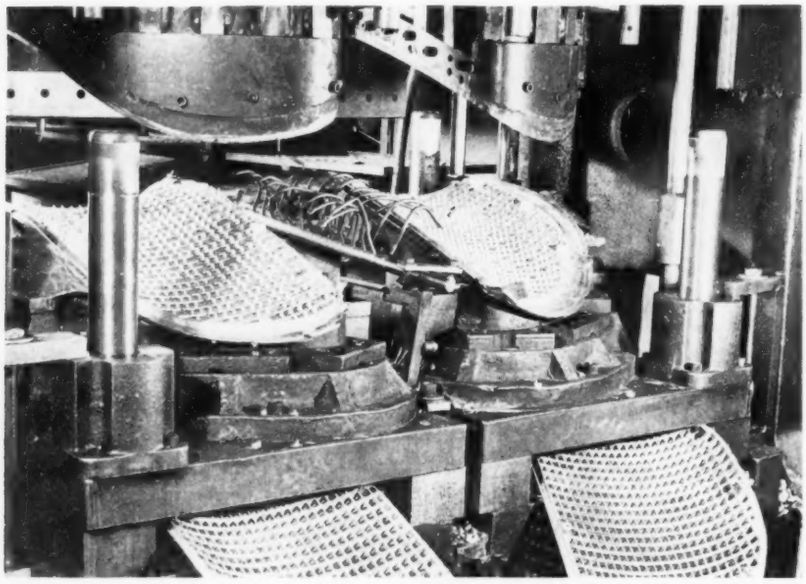
DEVELOPMENT of a duplicating attachment that will automatically contour mill the outside of the bosses of connecting rods should prove of interest to aircraft engine makers in this country and abroad. The tracer is set up to a master, the operator presses a button and then proceeds to load or unload as many as three other machines while the first one is automatically going through its cycle. The tracer follows around the entire contour and returns to the original starting point.

Successful operation of this attachment, which costs about 50 per cent as much as a first class milling machine, depends upon a two-way clutch that controls the table so as to proportion the depth feed to the cross feed in the correct manner. Smooth finish results, and the maker of the attachment believes that no further operations such as grinding would be required. The attachment can be used for cutting cams or any contour on common parts.

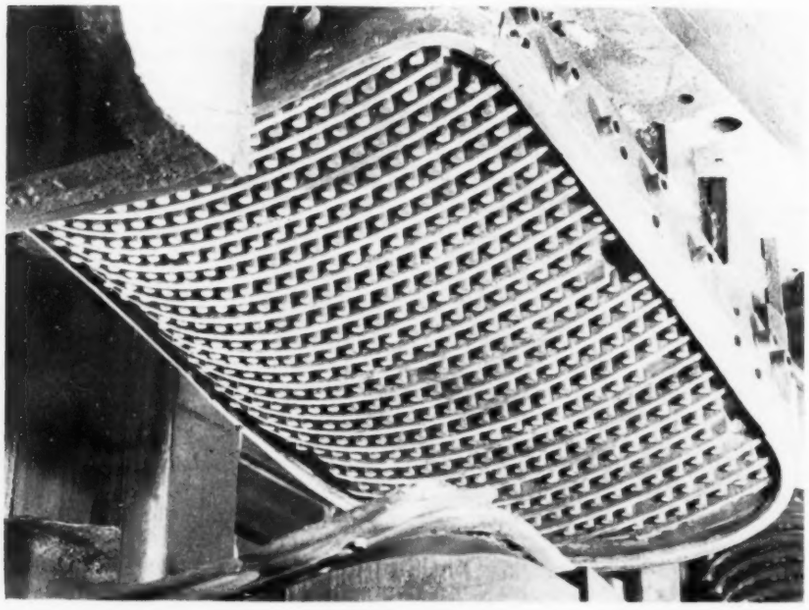
Knockout flash removal

BY HERBERT CHASE

Instead of shearing flash from each of 400 holes with precise punches, Doehler knocks it out with pins. It breaks properly



Dies which trim flash from Studebaker radiator grilles shear it from the outside contour in the usual way, but use round pins to knock it out of the square holes. Flash, sketch right, in each hole is thinnest at the edge, and has a cone in the center which contacts a knockout pin. Each pin, below, is slightly cupped and floats somewhat to permit centering on its individual cone



A BIG PROBLEM in producing die cast automobile radiator grilles is removing flash at parting lines. As a rule this is done with a trim die in a punch press. Such dies shear flash from the contour, and may carry punches which shear it simultaneously from spaces between grille bars.

But there are over 400 such square holes in a typical grille. Trim dies would be very expensive if punches to fit each hole were required, and a great deal of labor would be necessary to keep the punches sharp and in correct alignment. An effective way to avoid these difficulties has been developed by Doehler Die Casting Company for trimming flash from Studebaker grilles. Flash in each hole has cast in its center a cone, the axis of which is parallel to the press stroke. From the cone outward, the thickness of the flash decreases until at the joint with the four sides of the hole it is only a few thousandths of an inch. Punches are all circular. They are allowed to float within limits, and their ends are cupped so that as the die is closed they center on the cones. Further motion results in shearing the flash, but the punches do not touch the sides of the hole at all. The shear is remarkably clean, and relatively little filing is required. The punches, of course, do not require sharpening.

The die is made to cut flash from the casting contour in the usual way, with a true shearing action. A right and a left hand grill are required for each car, so the trim die is a duplex type which trims both at one stroke. As the grille has a warped surface, the lines where flash is sheared lie in similarly warped planes. Hence, although the axes of all cones are parallel, their bases lie at different angles in the warped parting surface. This, however appears to make no difference in shearing, which is as clean in one hole as in another. Approximately 70 pairs of grilles an hour are handled through the press.

A compressed air manifold between the dies carries pipes bent to blow flash away after the die opens. Two operators are used at the press, each loading and unloading one section of the die. Electrical interlocks are used for safety.

The Working of ALUMINUM ALLOYS

LIGHT weight, ease of fabrication, high resistance to corrosion, good thermal and electrical conductivity, and high metallic luster are characteristics which have helped make aluminum the fifth most commonly used structural metal. Aluminum weighs only about one-third as much as most of the common metals. Only beryllium and magnesium are lighter. The usual metalworking processes can be used for rolling, spinning, drawing, extruding and forging aluminum and its alloys. Complicated forms are produced by the sand-, permanent-mold and die-casting processes.

Commercially pure aluminum, in the annealed condition, is very ductile when cold and can be drawn to greater depths than can copper, brass or steel. It is relatively difficult to machine. Many of its alloys, however, are readily machinable. Commercially pure aluminum has poor casting characteristics, hence one of the alloys ordinarily is selected for making a cast part. Additions of small amounts of other metals, singly or in various combinations, substantially increase the physical properties of aluminum.

Broad generalizations as to the corrosion resistance of aluminum and its alloys are difficult, since corrosive action is determined by many factors. In general, alkalis will attack aluminum more rapidly than will acids. Often dilute acid solutions have a gerater solvent action than do concentrated acid solutions. Concentrated hydrochloric acid attacks aluminum vigorously, yet shipping containers made of this metal are used for concentrated nitric acid. However, dilute solutions of nitric acid often are as corrosive as hydrochloric or sulphuric acids when in contact with aluminum. Inhibitors, such as sodium silicate or potassium dichromate, sometimes are added to aluminum to reduce the solvent action of strong alkalis.

In contact with moist air, aluminum quickly acquires a thin, impervious film of aluminum oxide which serves as a protective barrier against further attack. A thicker oxide film can be formed electrolytically where greater resistance to certain types of corrosion is required. This oxide film is transparent and may be treated with dyes or inorganic pigments to color the surface.

Where aluminum or aluminum alloys are assembled in contact with other metals, and water is present, there is danger of galvanic attack of the aluminum. To prevent this electrolytic action, it is best to insulate the dissimilar metals with bituminous paint, fiber strips, or asphalt-saturated felt.

HISTORY OF ALUMINUM

Aluminum is the most abundant of all industrial metals. Estimates indicate that it makes up about 8 per cent of the earth's crust. It is the third most abundant element (following oxygen and silicon), but never is found in nature in its metallic form. It is an essential constituent of almost all important rocks, except the sandstones and limestones, and usually occurs as oxidized compounds with other elements.

It was not separated in metallic form until 1825, when Hans Christian Oersted, a Danish physicist and chemist, heated aluminum chloride with potassium amalgam. Frederick Wöhler, a German, obtained the metal in 1827 when he substituted metallic potassium for the amalgam used by Oersted. Henri Sainte-Clair Deville substituted metallic sodium for metallic potassium and started commercial production of the metal in a plant near Paris in 1856. His process was purely chemical, as were the processes used by those who preceded him.

It was not until 1886 that an economical means of producing metallic aluminum became available. In that year Charles Martin Hall, in the United States, and Paul Louis Toussaint Heroult, in France, independently discovered substantially similar electrolytic methods of extracting metallic aluminum from its oxides. The process used today for the production of aluminum is essentially the same as that discovered by Hall and Heroult.

Wilm's discovery, in Germany, that certain aluminum alloys were susceptible to improvement in mechanical properties by heat-treatment marked the opening of new fields for aluminum alloys. There now is available a series of strong, light aluminum alloys which, in wrought heat-treated form, have properties equivalent to those of mild steel.

Production of metallic aluminum on a commercial scale today is carried out in two major steps: (1) the preparation of *alumina* from bauxite, and (2) the electrolytic reduc-

This section was made possible through the cooperation of the following companies:

Aluminum Company of America
E. C. Atkins and Company
Blanchard Machine Company
Brown & Sharpe Mfg. Company
Bryant Chucking Grinder Co.
Carboloy Company
Cincinnati Bickford Tool Co.
Cincinnati Milling Machine Co.
Cincinnati Shaper Company
Cowles Detergent Company
Henry Disston and Sons
Eastern Machine Screw Co.
Geometric Tool Company
Greenfield Tap & Die Corp.
Hanson-Van Winkle-Munning Co.
Illinois Tool Works
Landis Machine Company
Landis Tool Company
Lincoln Electric Company
McKenna Metals Company
Michigan Tool Company
Milwaukee Metal Spinning Co.
Morse Twist Drill & Machine Co.
National Twist Drill & Tool Co.
Nicholson File Company
Norton Company
D. A. Stuart Oil Company
The Texas Company
Tide Water Associated Oil Co.
Vascoloy-Ramet Corporation

tion of aluminum from alumina in a molten bath of cryolite. A number of processes have been devised for obtaining alumina of high purity from the bauxite ore. The one now used almost universally is the "Bayer" process, in which the aluminum hydrate of the ore is dissolved out by means of a hot solution of sodium hydroxide, filtered to remove impurities, allowed to cool and treated to cause precipitation of aluminum hydroxide. This hydroxide then is separated by a second filtering operation and calcined to form pure aluminum oxide.

Successful operation of the Hall-Heroult electrolytic process is based on the solvent action of cryolite on alumina, and the fact that alumina, when dissolved in cryolite, can be decomposed by an electric current without effecting a change in the solvent cryolite. In the operation of the reduction cell, aluminum is separated continuously and is withdrawn from time to time as it collects in the bottom of the cell.

ALUMINUM-BASE ALLOYS

Metals most commonly added to aluminum in the production of commercial aluminum alloys are copper, silicon, manganese, magnesium, chromium, iron, zinc and nickel. These elements may be added singly, or some combination of them may be used to produce the desired characteristics in the resulting alloy. Where the alloy is to be used in wrought form, the total percentage of alloying elements seldom is more than 6 to 7 per cent. Appreciably higher percentages frequently are used in casting alloys.

Aluminum-copper alloys are widely employed because they are more easily cast than pure aluminum, are harder and stronger, and are more easily machined. Alloys containing up to 13 per cent silicon have excellent casting qualities, including fluidity and freedom from hot-shortness. Other advantages are high resistance to corrosion, low weight, low thermal expansivity, and high conductivity for heat and electricity. Elastic limits of aluminum-silicon alloys are, in general, lower than those of aluminum-copper alloys of about the same tensile strength. The aluminum-silicon alloys can be hardened by solution heat-treatment. Alloys containing substantial amounts of silicon are not so easy to machine as other aluminum alloys. There is a tendency for the metal to drag and pile up on the cutting surface of the tool, leaving rough surfaces on the work. The abrasive effect of the hard silicon particles leads to excessive tool wear. This has, in many cases, been overcome by using tungsten-carbide tools.

The addition of copper to aluminum-silicon alloys improves their machinability by decreasing their plasticity, but increases the abrasive effect of the silicon particles, since the increased hardness of the alloy holds these particles more firmly against the cutting tool. Aluminum-copper-silicon alloys can be greatly improved by heat-treatment. They are easily cast. Corrosion resistance of these ternary alloys is lower than that of either the binary aluminum-copper or aluminum-silicon alloys.

The wrought aluminum-copper-magnesium-manganese alloy (Alcoa 17S) commonly called *duralumin* is the oldest of the so-called "strong" aluminum alloys. It still is used for a wide variety of products. Where good forming characteristics are essential, and lower physical properties acceptable, a modified composition (Alcoa A17S) is available. This alloy frequently is used for rivets, because it can be driven in the fully heat-treated and aged condition. In the soft temper these alloys can be subjected to severe forming operations.

SAND-CASTING ALLOYS

Higher mechanical properties and superior casting qualities make aluminum-base alloys more suitable for castings than the commercially pure metal. Aluminum casting alloys are of two types: in the first group are those alloys in which improved properties result from alloying only, while in the second group heat-treatment processes are used to effect further improvement of the properties obtained by alloying.

Several alloys are available in each of these groups, the choice among them depending upon service requirements and, in some cases, on the ability to cast the desired part. Some are adapted for use at elevated temperatures, some are particularly resistant to corrosion, and some are more easily cast into complicated shapes. In the design of patterns for aluminum-alloy sand castings, a shrinkage of 0.156 in. per ft. usually is allowed.

Most aluminum-alloy sand castings are made of general-purpose alloys, many of which contain copper as the hardening agent. Alloys containing silicon as the hardener have excellent casting qualities and can be used in the production of large thin-sectioned castings of intricate design, or of castings which have adjoining heavy and light sections.

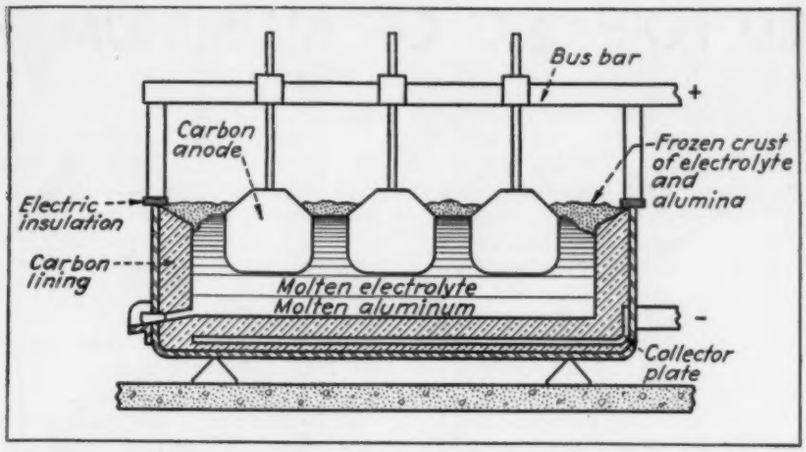
The use of heat-treated castings has increased rapidly since their introduction some time ago. The alloy in greatest use, Alcoa 195, contains about 4 per cent copper. Castings are produced in three heat-treated tempers, that produced by solution heat-treatment followed by room temperature aging (Alcoa 195-T4) being the one most commonly used.

Castings in Alcoa 220-T4 alloy have the highest combination of tensile and yield strengths, elongation and resistance to impact of any of the aluminum alloys. This alloy also has excellent machining qualities. The high magnesium content makes necessary the use of special foundry practices.

Some of the alloys used for sand castings also can be used in the production of permanent-mold castings;

PHYSICAL CONSTANTS OF PURE ALUMINUM

Atomic weight	26.97
Specific gravity at 20 C. (68 F.), g. per cu.cm	2.70
Weight at 20 C. (68 F.), lb. per cu.in	0.098
Weight at 20 C. (68 F.), lb. per cu.ft	168.56
Melting point, degrees Fahrenheit	1,220
Boiling point, degrees Fahrenheit	3,272
Latent heat of fusion, B.t.u. per lb	169
Heat of vaporization, B.t.u. per lb	3,510
Mean specific heat (32 to 212 F.), cal. per g	0.226
Thermal conductivity (32 to 212 F.), B.t.u. per sq. ft. per in. thickness per deg. Fahrenheit per hour	1,509
Electrical resistivity at 20 C. (68 F.), michrohms per cu. cm	2.65
Mean coefficient of thermal expansion per deg. Fahrenheit (68 to 572 F.)	0.0000142
Tensile strength, lb. per sq. in	9,000
Yield strength (set = 0.2 per cent), lb. per sq. in	3,000
Elongation in 2 in., per cent	60
Modulus of elasticity, lb. per sq. in	10,300,000
Modulus of rigidity (torsion), lb. per sq. in	3,870,000
Poisson's ratio	0.33
Reflectivity for white light, per cent	90
Compressibility (change in volume per megbar pressure)	0.0000014



Alumina is changed into aluminum, a silvery metal, in the Hall electrolytic cell. These steel cells are lined with carbon, which serves as the cathode. The carbon anodes reach into the cell from above. In the process, cryolite kept molten by the electric current, and alumina is dissolved in it. The current which passes through the molten bath electrolytically changes the alumina into oxygen, which reacts with the anodes, and metallic aluminum, which is deposited on the bottom

other alloys have been developed primarily for this purpose. Because of the finer grain structure resulting from the rapid solidification of the metal, permanent-mold castings have greater susceptibility to heat-treatment than do sand castings. In the case of aluminum-silicon alloys, the structure and mechanical properties are similar to those obtained by the modification process in sand castings.

The molds used in the permanent-mold process generally are made from special alloy cast iron. They may consist of two or more pieces, and either metal or sand cores be used. When metal cores are employed, it is necessary to withdraw them just as soon as the casting has set sufficiently, and before solidification shrinkage is complete. Otherwise, cracks are likely to occur in the casting because of the hot-shortness of practically all aluminum-base casting alloys.

DIE-CASTING ALLOYS

Choice of the alloy to be used for die castings is determined in some measure by the nature of the casting. Different alloys have different casting characteristics, and the ability to produce the most satisfactory casting of the desired design may be the deciding factor in the choice, rather than the mechanical properties as determined from a separately cast test specimen. Die castings ordinarily can be produced with tolerances of a few thousandths of an inch, while permanent-mold castings require tolerances of at least 1/64 in. and sand castings need much more.

While the initial cost of aluminum-alloy die castings is somewhat above that of die castings made from other white metals, they are light in weight, have superior resistance to corrosion, have a high degree of permanency of shape and dimension, and have good electrical and thermal conductivities. Most of the aluminum-alloy die castings are made from the aluminum-copper, aluminum-silicon or aluminum-copper-silicon groups of alloys.

WROUGHT ALLOYS

There are two types of wrought aluminum-base alloys, just as there are two types of casting alloys. In one class of the wrought alloys, the harder tempers with increased tensile properties are produced only by strain hardening, i.e., by cold working. In the second class of alloys, the higher strengths are produced by heat-treatment processes. Several alloys of each of these types, covering a wide range of physical properties and forming qualities, are commercially available in the forms into which metals are fabricated.

In the system of nomenclature adopted by the Aluminum Company of America for aluminum alloys, the wrought alloy numbers are followed by the letter *S*. The temper of the alloy is indicated by additional letters following the letter *S*, but separated from it with a hyphen. The letter *O* is used to indicate the annealed, or dead-soft, condition; in the strain-hardened alloys the letter *H*, indicates the full-hard condition. Intermediate tempers are shown as: quarter hard, $\frac{1}{4}H$; half-hard, $\frac{1}{2}H$; and three-quarter hard, $\frac{3}{4}H$.

The letter *O* also indicates the annealed condition in the heat-treatable alloys. The letter *T* following the alloy number indicates that the alloy is in its fully heat-treated and age-hardened condition. The symbol *W*, used only with the alloys which require artificial aging or precipitation heat-treatment, indicates that the alloy has been subjected to the solution heat-treatment, but has not been artificially aged. The temper which results from strain hardening an alloy after it has been heat-treated is designated by the symbol *RT*. Where the alloy is supplied with mechanical properties produced by a modification of the usual heat-treatment and strain-hardening processes, the temper is denoted by the letter *T* and a number like 11S-T3.

Hard tempers of the "common" (non-heat-treatable) aluminum-base alloys are produced by cold working. Of these alloys, commercially pure aluminum (Alcoa 2S) is the most easily worked. The annealed temper of each of the alloys is the best for the most severe forming operations. For many purposes the strengths of the non-heat-treatable alloys are entirely adequate, and their use offers the advantage of lower cost and greater ease of fabrication than do the heat-treatable alloys.

Normal use of the "strong" heat-treatable alloys is in the heat-treated condition—in the annealed temper they have mechanical properties comparable with those of certain of the "common" alloys. Of the heat-treatable alloys, Alcoa 17S or *duralumin* is the most extensively used. Its properties are obtained by heating at 930 to 950 F. and quenching in cold water, after which it is allowed to age for four days at room temperature. Hardening of heat-treatable alloys produced by cold working is accompanied by a loss of ductility—the elongation of these alloys when hardened by heat-treatment may be somewhat greater than that of the annealed material, although the plasticity and workability generally are less.

In all of the heat-treatable alloys, plasticity and workability are better directly after the solution heat-treatment than after age hardening, whether this be spontaneous or obtained by heating after quenching. The annealed temper of these alloys is best for severe cold-working operations, such as upsetting, bending, drawing and forming.

HOT AND COLD FORMING OF ALUMINUM

With its combination of strength, ductility and malleability, aluminum is adapted to fabrication by nearly all of the processes known to the metalworker. Many of the aluminum-base alloys also can be worked satisfactorily, although the conditions of working may be somewhat different than for pure aluminum. Commercially pure aluminum can be worked over a wide range of temperature. Cold working results in strain hardening the metal, but by proper annealing the metal can be softened again.

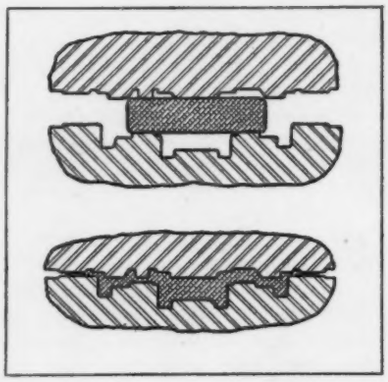
HOT FORMING

Hot forming has only limited application among the alloys whose tempers are produced by definite amounts of strain hardening by cold work. In the soft tempers all of these alloys have good forming qualities; if heated in the harder tempers, care must be exercised to avoid heating to the annealing temperature. At temperatures above 600 F. they are quite plastic, but on cooling to room temperature they are practically in the annealed state. Much improvement in bending qualities is obtained when working at 300 to 400 F., in which temperature range there is little loss in strength and hardness on cooling.

Heating may affect not only the mechanical properties of the heat-treatable alloys, but in some of the alloys may impair their normal resistance to corrosion. Heating to 400 F. materially improves forming qualities of these alloys; if held at this temperature for not more than one-half hour the loss in tensile values is practically negligible. At temperatures in the heat-treating range, the heat-treatable alloys are quite plastic and can be severely deformed. They may be reheat-treated after forming, or the heat may be removed by the forming dies with sufficient rapidity to constitute a quench, so that properties of the heat-treated tempers are developed after suitable aging. For some operations, somewhat lower forming temperatures give better results, in which case the part may be reheated to heat-treatment temperature and quenched in the die. Where this method is used, the dies must be of sufficient mass to provide rapid cooling of the alloy.

Forging of aluminum alloys differs from the forging of other metals principally in the temperature used and the limited range of working temperature for many of the alloys. Almost all aluminum alloys are hot-short, and many of them are cold-short. Frequent annealing between forging reductions is required for certain alloys when they are forged cold. In the design of the die, a draft of 10 deg. should be used for aluminum alloys. A shrinkage of $\frac{1}{8}$ in. per ft. ordinarily is allowed in the die cavity.

Aluminum alloy pressings may be made with hot or cold blanks, depending on the size of the part, its shape and the necessary displacement of the metal. Cold pressings ordinarily cannot be made if there must be considerable horizontal flow of the metal. Mechanical properties required in the finished part also have a determining effect on whether a hot or cold blank is to be used. In this method of forging, taper or draft can be reduced, thus minimizing machining after pressing. A smoother surface is obtained, since the displacement of the metal is accomplished in one blow. Hydraulic or mechanical presses may be used.



In hot or cold pressing of aluminum, the slug is placed in the cavity and in one blow the metal is caused to flow and assume the form desired. In most pressings, the metal is confined to a greater degree than is the case in the impact-extrusion process

COLD FORMING

When worked at temperatures below those required for annealing, aluminum and its alloys strain harden. The resultant increase in strength and reduction in ductility is, for most of the alloys, directly proportional to the amount of cold work when this working is within the range normally used for commercial manufacturing operations. Relative ease of forming the various grades and tempers, as well as the amount of cold forming that can be done, varies with the nature of the operation and the equipment employed.

The character of the cold work done on aluminum has little effect on the final mechanical properties obtained. A given amount of reduction by rolling, drawing or forging will give the metal the same final mechanical properties, provided the rate of reduction is the same. Rate of working, or rate of reduction, per pass, draw or blow may cause some variation in mechanical properties.

Shearing of aluminum and aluminum alloys readily can be accomplished in power-driven squaring shears or rotary shears where thickness is less than $\frac{1}{2}$ in. Shearing tools should be sharp and a proper clearance must be allowed if the sheared edges are to be smooth and free from burrs. Usually a clearance of one-eighth of the thickness of the sheet or plate is sufficient in die-punching operations and can be employed in squaring shears when provided with a mechanical hold-down. A low rake or shearing angle on the upper shear knife reduces twist in thin stock. Walls of the opening in dies for blanking are tapered away from the cutting edge 3 to 5 deg. to permit punched pieces to fall freely. Material thicker than $\frac{1}{2}$ in. should be sawed.

In drawing operations, the amount of reduction in diameter of the blank or shell during each draw has an important relation to the possible depth of draw and the smoothness of the finished product. A deeper shell can be drawn without an intermediate anneal when the diameter is reduced by series of easy draws than when the shell is completed in one draw. Generally, the diameter of the blank should not be reduced more than 40 to 50 per cent in the first draw, and partially drawn shells should not be reduced in diameter by more than 25 per cent per draw.

Close-grained cast iron, semisteel, or hardened tool steel may be used in making tools for press drawing or stamping operations. Radius of drawing edge is an important element of draw die design. If this radius is too small, tearing may occur, and if too great, wrinkling of the stock is to be expected. Preferred

APPLICATIONS OF TYPICAL ALUMINUM-BASE ALLOYS

Aluminum Co. of America Alloy Number	Forms Commonly Available														CHIEF CHARACTERISTICS	TYPICAL APPLICATIONS
	Sheet and Plate	Wire	Rod and Bar	Rolled Shapes	Extruded Shapes	Tube and Pipe	Rivets	Screw Mach. Products	Forgings	Sand Castings	Perm.-Mold Castings	Die Castings	"Alclad" Sheet	Heat-Treatable Alloy		
2S	●	●	●	..	●	●	●	..	..	..	..	..	..	..	Good forming qualities, resistant to corrosion, weldable.	Sheet metal work, chemical equipment, cooking utensils.
3S	●	●	●	..	●	●	●	..	..	..	..	..	..	..	Workability, weldability and resistance to corrosion.	Sheet metal work, decorative trim, gasoline tanks for aircraft.
11S	..	●	●	..	..	..	..	●	●	..	..	..	..	●	Good machinability, "free" cutting, good mechanical properties.	Screw-machine products.
14S	..	..	..	..	..	..	..	..	●	..	..	..	..	●	Highest strength and hardness of all aluminum alloys.	Heavy-duty forgings, power shovel bails, airplane fittings.
17S	●	●	●	●	●	●	●	●	●	..	..	..	●	●	Excellent mechanical properties. (Duralumin type alloy.)	Structural applications in construction and transportation fields.
A17S	..	..	..	..	..	..	●	..	..	..	..	..	..	●	Fair strength and cold-working properties.	Rivets.
18S	..	..	..	..	..	..	..	..	●	..	..	..	..	●	Good strength at elevated temperatures.	Forged aircraft-engine pistons.
24S	●	●	●	..	●	●	..	●	..	..	..	..	●	●	High strength, sensitive to heat-treatment.	Widely used in aircraft construction.
25S	..	..	..	..	..	..	..	..	●	..	..	..	..	●	Excellent workability when hot, high strength.	Complicated forgings.
32S	..	..	..	..	..	..	..	..	●	..	..	..	..	●	Comparatively low coefficient of thermal expansion.	Forged aircraft-engine pistons.
A51S	..	..	..	..	..	..	..	..	●	..	..	..	..	●	Excellent workability when hot, high strength.	Intricate forgings, machine and automotive parts.
52S	●	●	●	..	..	●	..	..	..	..	..	..	..	..	Highest strength of non-heat-treatable aluminum alloys, good workability and resistance to corrosion.	High-strength sheet metal work, marine and transportation applications.
53S	●	●	●	●	●	●	●	●	●	..	..	..	..	●	Fair mechanical properties, excellent resistance to salt-water corrosion.	Structures subject to severe corrosive conditions; naval, architectural and industrial applications.
61S	●	..	..	..	●	●	..	..	..	..	..	..	..	..	Good strength and workability.....	General-purpose casting alloy.
13	..	..	..	..	..	..	..	..	..	..	●	●	..	..	Excellent foundry characteristics, good mechanical properties, resistant to corrosion.	General-purpose alloy for large, intricate parts.
43	..	..	..	..	..	..	..	..	..	●	●	●	..	..	Good foundry characteristics, weldability, good resistance to corrosion, pressure tightness.	Castings that must be leakproof under pressure, architectural trim, sewage disposal plants, pipe fittings.
47	..	..	..	..	..	..	..	..	..	●	..	..	..	★	Good foundry characteristics, improved mechanical properties over Alcoa 43 alloy.	High-strength intricate castings, leakproof castings.
81	..	..	..	..	..	..	..	..	..	..	..	●	..	..	Satisfactory foundry characteristics and mechanical properties for simple castings of moderate thickness.	Small, simple parts.
83	..	..	..	..	..	..	..	..	..	..	..	●	..	..	Good foundry characteristics, good ductility.	Parts requiring spinning or other forming operations.
85	..	..	..	..	..	..	..	..	..	..	..	●	..	..	Best combination of strength and ductility of the die-casting aluminum-base alloys.	Brackets, frames, levers with thick sections.
108	..	..	..	..	..	..	..	..	..	●	..	..	..	..	Good foundry characteristics, pressure tightness.	Manifolds, valves and other intricate castings requiring pressure tightness.
A108	..	..	..	..	..	..	..	..	..	..	●	..	..	..	Good foundry characteristics.....	Ornamental grilles, general-purpose castings.
112	..	..	..	..	..	..	..	..	..	●	●	..	..	..	Widely used general casting alloy; good casting and machining characteristics.	General-purpose castings, crankcases, oil-pans, cylinder heads, differential carriers and other automotive applications.
B113	..	..	..	..	..	..	..	..	..	..	●	..	..	..	Good foundry characteristics, good machining properties.	Washing machine agitators, general-purpose castings.
C113	..	..	..	..	..	..	..	..	..	..	●	..	..	●	Modification of Alcoa B113 alloy with better pressure tightness.	Automotive-engine cylinder heads, general purpose castings.
122	..	..	..	..	..	..	..	..	..	●	●	..	..	●	High hardness, resistance to wear, useable at elevated temperatures.	Auto engine pistons, camshaft bearings, valve tappet guides.
A132	..	..	..	..	..	..	..	..	..	..	●	..	..	●	Low coefficient of thermal expansion, retains strength at high temperatures.	Pistons for internal-combustion engines.
108	..	..	..	..	..	..	..	..	..	..	●	..	..	..	Excellent hardness, which is retained at elevated temperatures.	Flatiron sole plates.
142	..	..	..	..	..	..	..	..	..	●	●	..	..	●	Retains strength at elevated temperatures, has good bearing characteristics.	Pistons and cylinder heads.
195	..	..	..	..	..	..	..	..	..	●	..	..	..	●	Good mechanical properties; resistant to salt-spray corrosion.	Machine bases and parts, shop crane trucks, trolley parts, outboard motors, ship castings, aircraft engine parts.
B195	..	..	..	..	..	..	..	..	..	..	●	..	..	●	Widely used modification of Alcoa 195 alloy.	Permanent-mold castings (products same as for Alcoa 195 alloy).
212	..	..	..	..	..	..	..	..	..	●	..	..	..	..	General-purpose casting alloy; has improved foundry characteristics over Alcoa 112 alloy.	General-purpose castings of intricate design.
214	..	..	..	..	..	..	..	..	..	●	..	..	..	..	Resistant to severe corrosive conditions, excellent mechanical properties.	Carburetor cases, machine parts, pipe fittings.
A214	..	..	..	..	..	..	..	..	..	..	●	..	..	●	Excellent mechanical properties, good resistance to corrosion and tarnishing.	Cooking utensils.
218	..	..	..	..	..	..	..	..	..	..	..	●	..	..	High mechanical properties, resistant to corrosion, easily finished.	Marine fittings, hardware.
220	..	..	..	..	..	..	..	..	..	●	..	..	..	●	Highest strength and shock resistance of casting alloys, good resistance to corrosion.	Aircraft fittings, railroad car parts, heavy-duty castings, power shovel dipper parts, marine applications.
A334	..	..	..	..	..	..	..	..	..	●	..	..	..	..	Better tensile properties than Alcoa alloys No. 108, 112 and 212.	Automotive-engine parts, air-brake valves.
335	..	..	..	..	..	..	..	..	..	●	●	..	..	●	Good foundry characteristics, resistant to corrosion, strong at elevated temperatures.	Cylinder heads and crankcases for Diesel and aircraft engines.
A335	..	..	..	..	..	..	..	..	..	●	..	..	..	●	Modification of Alcoa 355 alloy.....	Same as Alcoa 355 alloy for operating temperatures above 400 F.
356	..	..	..	..	..	..	..	..	..	●	..	..	..	●	Good foundry characteristics, weldability, pressure tightness, and resistance to corrosion.	High-strength, pressure-tight castings of intricate shape.
645	..	..	..	..	..	..	..	..	..	●	..	..	..	●	Good mechanical properties, low resist- corrosion.	Machine parts not subjected to elevated temperatures or corrosive conditions.

★ — Properties obtained by "modification" practice in the foundry.

radius of the edge of the punch is twice the thickness of the metal being drawn. Minimum draw radius on the die is about three times the metal thickness. Polished die and punch surfaces are best, since aluminum has a tendency to stick to the steel die surfaces.

Frequently, successful results in drawing or stamping operations depend on the lubricant used. A light mineral oil may be used for blanking and stamping operations. For deep-drawing, an oil of considerable body is required. The best lubricant is tallow, mixed with a small amount of mineral oil, but because of its cost and the greater difficulty of application and removal it is used only for the more difficult operations. The lubricant should be applied to both sides of the sheet.

IMPACT EXTRUSION

Virtually a "cold squirting" operation, impact extrusion of aluminum is possible only because of the high ductility of the metal. In this process slugs are placed one at a time in the cup-shaped die of a power press. Diameter of the die corresponds to the outside diameter of the part to be formed, while the diameter of the punch is the same as that desired on the finished part. The punch strikes the slug a single, downward blow with tremendous force, causing the metal in the slug to *squirt* up around the punch through the clearance between the punch and the die. The lower section of the die has the shape desired as the contour at the closed end of the part, and the lower end of the punch is shaped to conform to the contour desired inside the closed end of the part. When the punch is withdrawn, the part is stripped off.

A variation of the impact-extrusion process is the "Hooker" process for extruding small tubing with plain or modeled contours. This process reverses the usual impact method in that the metal is forced downward through an opening in the bottom of the die. The metal takes the shape between the cavity wall and the punch-point.

SPINNING

There is no essential difference in the process used for making spun articles of aluminum and aluminum alloys from that used for copper and brass, except that higher speeds (up to about 4,000 ft. per min.) are employed. Spinning is used for shaping round and oval symmetrical articles when quantities are too low to justify tools for other forming methods, or when the size or design is such as to make drawing difficult. The process is suitable only for commercially pure aluminum and a few of the more ductile alloys.

For most spun articles the amount of strain hardening is not enough to necessitate an intermediate anneal. In some complicated re-entrant forms it may be best to spin the part over first one chuck and then another, just as several draw dies sometimes are used. When the metal must be annealed before completing a spinning operation, a torch may be played on the partially spun piece while it is rotating in the lathe.

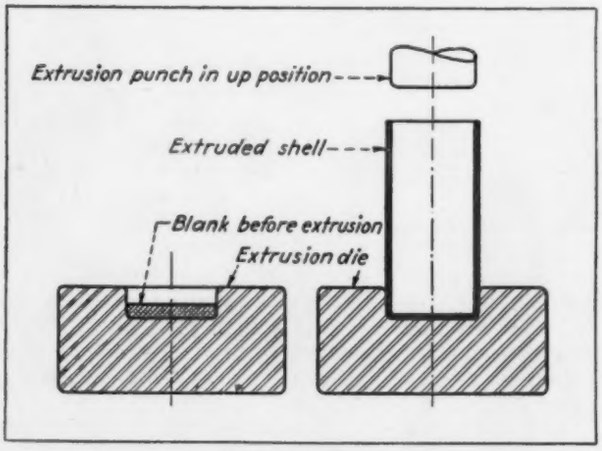
Aluminum sheet from 0.025 to 0.080 in. thick is spun with hand tools; a tool post is used in addition to hand tools when working on heavier sheet. Hickory sticks usually are employed for the breakdown of circles, then steel tools are used. While some operators need more tools than others, the three essential tools are a half-round former, a diamond-shaped trimmer and a beading tool. These are made of high carbon steel, forged to shape, hardened, polished, then fitted with hardwood handles.

Lubrication during spinning is important. Beeswax, tallow, and lard oil, mixed with white lead or vaseline, are suitable for small pieces. Ordinary yellow kitchen soap serves well when spinning large blanks which require heavy tool pressure. Speed of spinning depends on the size of the part and the severity of reduction—the rest depends on the skill of the operator.

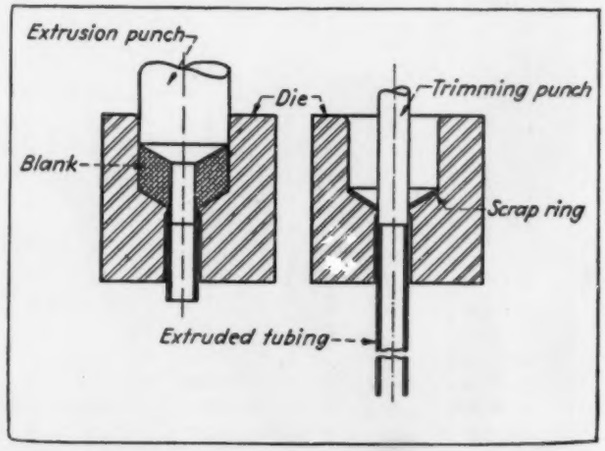
HAMMERING

When only a few pieces of a given shape are to be made, they frequently are made by hammering or "beating" instead of drawing or spinning. The hammering may be done with a wood mallet over a wood form, although pneumatic hammers sometimes are used. Usually the sheet is clamped to the form.

Occasionally sheets are formed under a high-speed hammer. The anvil and the mechanically driven hammer are curved slightly so that when the hammer hits the sheet it curves the metal. The operator, who must be highly skilled, moves the sheet between strokes of the hammer so that the desired dishing results. Comparison with a templet guides the operator.



When the punch strikes the slug in the impact-extrusion process the metal squirts through the opening between the punch and the die to form the desired part in one operation



Essentially the same as impact-extrusion, the Hooker process forms small tubing by forcing the metal in the slug to flow downward through an opening in the bottom of the die

HEAT-TREATMENT OF ALUMINUM ALLOYS

There are a number of aluminum-base alloys whose physical properties may be improved by heat-treatment. All of them may be softened after strain hardening by annealing at proper temperatures.

Hardening constituents in the heat-treatable alloys are elements whose solid solubility in aluminum is much higher at elevated temperatures than at room temperatures. Grain refinement is not a factor in improvement of properties by thermal treatment, as there are no phase changes in solid aluminum below the melting point. Heat-treatment simply is a means for distributing efficiently the alloying ingredients.

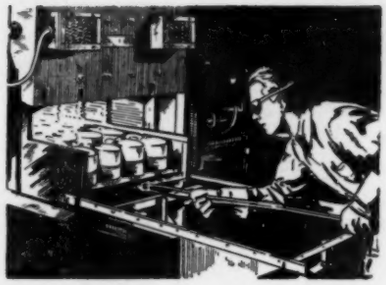
In ordinary commercial practice there are three types of thermal treating processes applied to wrought aluminum alloys. In certain cases these processes also are applied to some cast aluminum alloys.

ANNEALING

Strain hardening which results from cold working aluminum alloys may be removed by heating to permit recrystallization. Both batch furnaces and continuous furnaces can be used for the annealing operation. These furnaces may be of the full-muffle or semi-muffle design, and may be heated by oil, gas, or electricity.

Complete softening is almost instantaneous for most of the alloys hardened by cold working when heated to a temperature in the range of 640 to 670 F., but for Alcoa alloys 3S and 4S temperatures of 750 F. or higher are used. Heating for longer times at somewhat lower temperatures will accomplish similar results. Temperature of annealing is not critical, once the metal has reached the instantaneous annealing point, but it is desirable that the recommended values should not be greatly exceeded. Rate of cooling of non-heat-treated alloys from the annealing temperature is not important.

Care is required in determining annealing conditions for the heat-treatable alloys. While the metal must be raised to a temperature which will permit recrystallization, it must be maintained as low as possible in order to avoid heat-treatment effects which would prevent complete softening of the alloy, or the cooling rate must be so slow as to counteract the effect of such heating. Heating these alloys to 650 F. ordinarily is sufficient to remove the strain hardening which



results from cold working. This temperature should not be exceeded by more than ten degrees, nor should the metal temperature in any part of the load be less than 630 F. Rate of cooling is not important if the maximum temperature limit has not been exceeded, but slow cooling to about 450 F. is recommended in case any part of the load may have been heated above the recommended temperature.

This annealing practice, in addition to removing the hardening effects of cold working, also removes most of the effect of heat-treatment when applied to metal in the heat treated temper. If the metal must be completely annealed, as for severe forming operations, the heat-treated alloy must be heated for about two hours at a temperature of 750 to 800 F., and then allowed to cool slowly in the furnace to about 450 to 500 F. with a cooling rate under 50 F. per hour.

SOLUTION TREATMENTS

Solution heat-treatment of aluminum alloys commonly is carried out in molten salt baths or in air furnaces. The salt bath usually consists of fused sodium nitrate. The air furnaces used ordinarily are heated electrically. When small parts, such as rivets, are to be heat-treated, a small gas or oil heated pot of molten nitrate or lead frequently is used. The parts are placed in a steel tube with the bottom closed and the top covered, the tube being immersed in the bath to within a short distance of the top.

Accurate temperature control is necessary if proper results are to be obtained with heat-treatable aluminum alloys. Temperature limits for the solution heat-treatment are close and it is essential that these limits be adhered to. The temperature range for the solution heat-treatment of 17S and A17S is from 930 to 950 F. For 51S and 53S alloys, the temperature should be 970 F., making certain that the temperature is within ten degrees of this value. For alloy 24S, the temperature range is 910 to 930 F. Time of heating depends on the load, nature of the material and type of heating equipment. In a nitrate bath, a period of 25 min. usually is sufficient; somewhat shorter times have given satisfactory results. Where air is the heating medium, heating may require several hours.

QUENCHING

After the alloy has been heated for the required time for solution heat-treatment, it is removed from the furnace and quenched in cold water. Time interval between removal of the metal and its quenching should be as short as possible, not more than a few seconds, if best results are to be obtained. If the metal is permitted to cool in air during transfer to the quenching tank the resistance to corrosion may be impaired. Volume of quenching water should be sufficient that its temperature will not be raised above 150 F. by the heat of the load. When a nitrate heating bath has been used, it is necessary that any adhering nitrate be completely washed from the metal in order to avoid corrosion.

PRECIPITATION TREATMENTS

Precipitation heat-treatment, necessary for certain of the heat-treatable alloys, usually is carried out in an electrically heated oven or by means of steam coils, and provided with a fan for air circulation. For small articles an oil bath often serves adequately. The temperature range and time vary with different alloys. For Alcoa 61S and 53S, the preferred temperature limits are 310 to 320 F., and the aging time is eighteen hours. Aging for too long a time or at too high a temperature will lower the elongation and eventually the tensile strength of the alloy. If the temperature is too low, much longer aging periods are required to bring about the proper improvements of the alloys. Precipitation heat-treatment is often, but not always, preceded by the solution heat-treatment. The following precipitation treatments have been found suitable for the alloys indicated: Alcoa 25S, 4 to 15 hr. at 285 to 295 F.; Alcoa 195 (cast), 1 to 18 hr. at 310 to 320 F.

It is well to note that certain heat-treatment processes for aluminum alloys, and the heat-treatment of certain of the alloys, are subject to patent restrictions.

MACHINING PRACTICE FOR ALUMINUM

Compared with other commercial metals, aluminum and its alloys are machined readily. While tools used for steel sometimes will give good results, best practice is to use greater back and side rake angles. Frequently tools for aluminum alloys resemble those used in cutting hardwoods. High-carbon and high-speed tool steels ordinarily are satisfactory. Tools tipped with tungsten carbide show a marked improvement since their cutting edges remain sharp for long periods without grinding.

No matter what the material used for the tool, it is essential that the cutting edges be keen, smooth and free from grinding scratches, burrs or wire edges. Fine abrasive wheels should be used when sharpening; this should be supplemented by hand stoning. It is possible to machine aluminum and some of its alloys without a lubricant or cutting compound. Good practice, however, calls for the use of a cutting lubricant applied at the point of cutting.

It is important to remember that aluminum alloys in cast and wrought forms may be distorted under heavy machining cuts. Frequently special fixtures must be devised to hold the part so that distortion is reduced to a minimum. Ordinarily, it is best to use high speeds and fine to medium feeds. Recommended surface speeds vary widely, depending on the material from which the cutting tool is made, the characteristics of the part and the alloy from which it is made, and the rigidity of the cutting set-up.

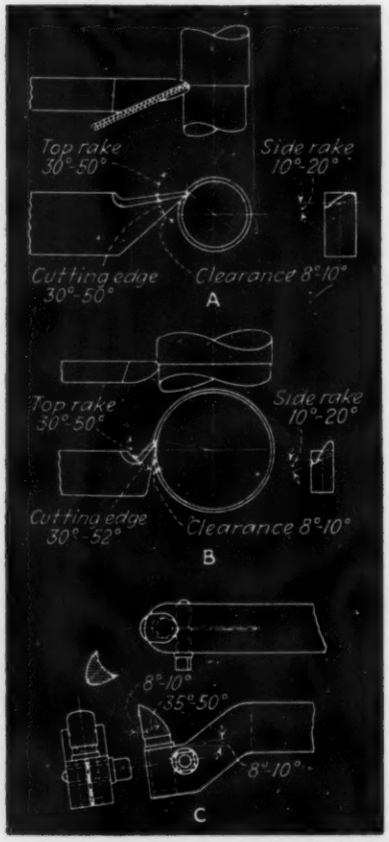
TURNING AND BORING

Tools satisfactory for most lathe operations are shown. In general, these tools should have appreciably more back and top rake than used for cutting steel. Their edges should be keen and smooth, and usually they should be set above the center line of the work to reduce any tendency to chatter. It is important that there be sufficient side and front clearance.

A round-nosed tool usually works best. The same tool may be used for finishing as for roughing, but just before finishing the edge should be re-stoned. Frequently, good results are obtained when the cutting edge of the tool is set considerably above center, up to about 45 deg. above the horizontal diameter. With such a setting, the chips, which should be long and straight, clear the work and the machine to better advantage.

Specific values for the angles to which the cutting edge of a tool should be ground must be governed by the work to be done and the requirements of the job. With high-speed tool steel tools, a back rake of 30 to 50 deg., a side rake of 10 to 20 deg., a total angle of cutting edge of 35 to 55 deg., and a front clearance of 6 to 8 deg. ordinarily will work well. In general, a top rake of 12 to 20 deg. and a front clearance angle of 3 to 4 deg. are sufficient for parting tools made of high-speed steel.

Cutting angles should be reduced to increase strength of the cutting edge when the operation involves considerable abuse, as when turning or facing lugs or bosses. Rake angles may be decreased when machining free-cutting alloys. Both top and side rake angles generally are increased when machining the "gummy" alloys.



A round-nose tool set carefully for proper clearance works best for engine lathe turning. The tool shown at A *works well on small diameters, while the tool at* B *is used for large diameters. Bit of tool shown at* C *is made from round stock, and is sharpened easily*

Maximum support of cutting edge is desirable on using carbide-tipped tools.

Feeds, speeds and tool shapes, together with suitable carbide grades, suggested by Carboloy for machining aluminum alloys, are tabulated. The values given are conservative; often the feeds and rake angles used in practice are in excess of those shown. Kennametal-tipped tools with back-rake angles of 20 to 27 deg. produce cleanly cut surfaces. A speed of 1,000 ft. per min. is possible on some jobs with grade KH Kennametal. Speeds of 300 to 1,500 ft. per min. are suggested for Vascoloy-Ramet tipped lathe tools when they are ground to have a clearance of 8 deg. and an effective rake angle of 8 to 15 deg. Grades 2A5, 2A7 and 2A9 tantalum-tungsten carbides are suitable for aluminum and its alloys. When the aluminum tends to build up at the cutting edge, Vascoloy-Ramet grade AT, which contains a higher percentage of tantalum carbide is used.

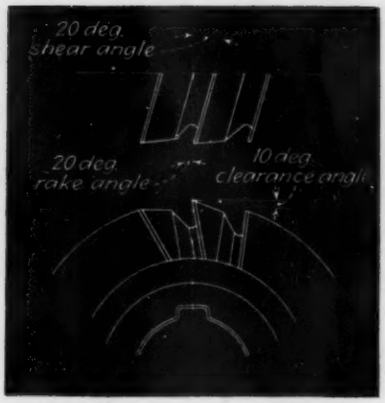
SCREW-MACHINE WORK

Both high-speed steel tools and carbide-tipped tools are used for screw machine operations. The two aluminum alloys commonly used for screw machine stock are Alcoa 11S-T3 and 17S-T. The 11S-T3 alloy cuts more freely than 17S-T, and it forms smaller chips. Cutting characteristics of the two alloys are similar with respect to surface speed, lubricant and types of tools used. Ordinarily, the 11S-T3 alloy is more flexible with regard to tool angles and tool feeds.

Generally, form tools are made for use without top rake, especially when machining Alcoa 11S-T3. For machining 17S-T alloy, a top rake of 5 deg. is advantageous in the production of a smooth finish. Both form and cut-off tools are made with a 0.5 deg. side clearance. Front clearance angles common in screw machine practice are satisfactory for these two alloys.

A chip curler groove frequently is ground in the cutting edge of box tools for Alcoa 17S-T alloy; no groove is necessary for the freer-cutting 11S-T3 alloy. For long, heavy cuts, it is advisable to put a series of small notches in the cams of the machine, thus providing an interrupted feed which breaks the turnings.

Tool feeds vary with cutting conditions, as well as with requirements of tolerance and finish. Overlapping operations and the condition of the



Milling cutters of both the solid and the inserted-blade types are used for aluminum alloys. Opinions vary as to best cutting angles, those shown have worked well in general practice

machine may require lower feeds than normal. Usually, cutting compounds used for other metals in screw machine practice are suitable for the free-cutting aluminum alloys.

PLANING AND SHAPING

Since work ordinarily can be set up securely for planing and shaping operations, cutting speeds for aluminum and its alloys ordinarily are limited only by the machine. Occasionally, heavy cuts possible in these operations will compensate to some extent for the necessarily low permissible cutting speed. The tool should be prevented from striking the finished work during the returned stroke. If this occurs, the work may be scratched and the thin cutting edge broken.

For light cuts, a round inserted-blade tool with a front clearance angle of 6 deg., a back rake of 45 deg. and a side rake of 8 deg. works well. Solid cutting tools should be used for the heavier cuts, especially when roughing. The tool shown for finishing cuts has a larger side rake angle than does the roughing tool, and the long sweep of the cutting edge produces a slicing action which cuts freely.

MILLING

Either solid-tooth or inserted-blade milling cutters work well on aluminum and its alloys. These cutters should be of the coarse-tooth helical type, and should have a considerable amount of top rake on the cutting edges. Nicked teeth assist in decreasing chip size. Face-milling cutters with inserted teeth should be designed so that the blades will have appreciable top and side rake.

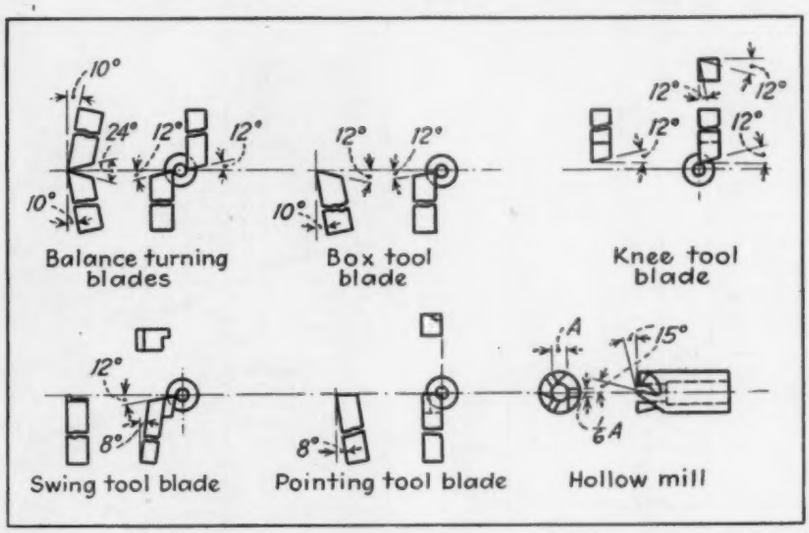
Milling speeds range from 500 to 1,500 ft. per min. with the feed per revolution approximately 1/500 of the surface speed. The softer and more ductile the alloy, the higher should be the cutting speed, feed and hook angles. For large work, tungsten-carbide-tipped inserted-blade cutters should be considered. Milling cutters with a rake angle of about 20 deg., a shear angle of 20 deg., and a clearance angle held close to 10 deg. generally prove satisfactory when milling aluminum alloys.

DRILLING

A so-called "fast helix" drill, with a 35 to 45 deg. helix angle of flute, works well when drilling aluminum, although standard twist drills sometimes are satisfactory. Flutes should be highly polished. An included point angle of 90 deg. is recommended for wrought aluminum alloys, while a 140 deg. point may be desirable in cast aluminum. In some instances a single flute drill with about 40 deg. helix, such as is used when drilling hardwood, works better than a two-flute twist drill. Lip clearance angle should be about 12 deg. Drilling speeds range from 150 to 300 ft. per min., depending on the type of drill, the alloy, and the depth of hole.

REAMING

Right-hand 7 to 10 deg. helical-fluted reamers for right-hand cut with radial cutting faces give very smooth holes in aluminum. Such a reamer has almost a burnishing action. The flutes must be highly polished to give a keen cutting edge if a good finish is to be obtained. One supplier of reamers suggests relieving the lands to a "white line" and then relief stoning the white line to the cutting edge. Speeds of 175 to 200 ft. per min. up to 1 in. diameter and 140 to



These screw machine tools made of high-speed tool steel usually work well on Brown & Sharpe automatics when machining "free cutting" aluminum alloys like Alcoa 11S-T3 and 17S-T

SPEEDS AND FEEDS FOR ALUMINUM ALLOYS

Depth of Cut	Max. Feed Per Rev.	Cast Alloys (As Cast) Wrought Alloys (Hard Rolled) Cutting Speed (Ft. per Min.)		Carboloy Grade	
				Average Production	Quantity Production
Inch	Inch	Start	Range		
1/64–1/32	0.010	350	300–500	883	905
1/32–1/16	0.020	300	250–350	883	905
1/16–1/8	1/32	200	150–300	883	905
1/8–1/4	1/32	125	80–150	44A	883

From starting speed suggested, cutting speed should be adjusted upward or downward, as necessary, within the range indicated to suit the conditions of the individual application. Under proper conditions, the speeds shown may be exceeded. These data apply when tool has a front clearance angle of 6-10 deg., a side clearance angle of 6-10 deg., a back rake of 5-15 deg., and a side rake of 8-15 deg.; with polished cutting edge.

CHARACTERISTICS OF WROUGHT AND CAST ALUMINUM-

TYPICAL ALUMINUM-BASE ALLOYS[2]				APPROXIMATE CHEMICAL COMPOSITION (Per Cent) (Aluminum and normal impurities constitute remainder of alloy)																			
A. S. T. M. Designation		S. A. E. Alloy No.	Aluminum Co. of America Alloy No.	Copper	Silicon	Manganese	Magnesium	Zinc	Nickel	Chromium	Lead	Bismuth	Iron	Condition	Approx. Specific Gravity (Grams per cu. cm.)	Approx. Weight (Lb. per cu. in.)	Relative Resistance to Salt Water[7] (A = Highest Rating)	STRENGTH IN TENSION[4] Ultimate Tensile Strength (1,000 lb. per sq. in.)	STRENGTH IN TENSION[4] Yield Strength[3] (1,000 lb. per sq. in.)	STRENGTH IN TENSION[4] Elongation (Per Cent in 2 in.) Sheet Specimen (1/16 in. thick)	STRENGTH IN TENSION[4] Elongation (Per Cent in 2 in.) Rod Specimen (1/2 in. diam.)	STRENGTH IN COMPRESSION[4] Yield Strength in Compression (1,000 lb. per sq. in.)	STRENGTH IN COMPRESSION[4] Shear Strength[5] (1,000 lb. per sq. in.)
Spec. No.	Alloy																						
Wrought Alloys																							
B 25-38T	.....	25	2S-O	....	....	....	....	....	....	....	....	....	....	Annealed	2.71	0.098	A	13	5	25	45	5	9.5
B 25-38T	.....	25	2S-H	....	....	....	....	....	....	....	....	....	....	Hard	2.71	0.098	A	24	21	5	15	21	13.0
B 79-38T	.....	29	3S-O	....	....	1.2	....	....	....	....	....	....	....	Annealed	2.73	0.099	A	16	6	30	40	6	11.0
B 79-38T	.....	29	3S-H	....	....	1.2	....	....	....	....	....	....	....	Hard	2.73	0.099	A	29	25	4	10	25	16.0
.....	.....	...	11S-T3	5.5	....	....	....	....	....	....	0.5	0.5	....	H. T. & Aged	2.82	0.102	D	49	42	..	14	42	30.0
.....	.....	...	11S-T8	5.5	....	....	....	....	....	....	0.5	0.5	....	H. T. & Aged	2.82	0.102	D	55	42	..	14	42	....
B 78-39T	.....	26	17S-O	4.0	....	0.5	0.5	....	....	....	....	....	....	Annealed	2.79	0.101	D	26	10	20	22	10	18.0
B 78-39T	.....	26	17S-T	4.0	....	0.5	0.5	....	....	....	....	....	....	H. T. & Aged	2.79	0.101	C	60	37	20	22	37	36.0
.....	.....	...	A17S-T	2.5	....	....	0.3	....	....	....	....	....	....	Heat-Treated	2.74	0.099	C	43	24	24	27	24	26.0
.....	.....	24	24S-O	4.6	....	0.6	1.5	....	....	....	....	....	....	Annealed	2.77	0.100	D	26	10	20	22	10	18.0
.....	.....	24	24S-T	4.6	....	0.6	1.5	....	....	....	....	....	....	Heat-Treated	2.77	0.100	C	68	44	19	22	44	41.0
.....	.....	24	24S-RT	4.6	....	0.6	1.5	....	....	....	....	....	....	Heat-Treated	2.77	0.100	C	70	55	13	..	55	42.0
B109-39T	.....	201	52S-O	....	....	....	2.5	....	....	0.25	....	....	....	Annealed	2.67	0.096	A	29	14	25	30	14	18.0
B109-39T	.....	201	52S-H	....	....	....	2.5	....	....	0.25	....	....	....	Hard	2.67	0.096	A	41	36	7	8	36	24.0
.....	.....	....	53S-O	....	0.7	....	1.3	....	....	0.25	....	....	....	Annealed	2.69	0.097	A	16	7	25	35	7	11.0
.....	.....	....	53S-W	....	0.7	....	1.3	....	....	0.25	....	....	....	Quenched	2.69	0.097	A	33	20	22	30	20	20.0
.....	.....	....	53S-T	....	0.7	....	1.3	....	....	0.25	....	....	....	Heat-Treated	2.69	0.097	A	39	33	14	20	33	24.0
.....	.....	....	61S-O	0.25	0.55	....	0.95	....	....	0.25	....	....	....	Annealed	2.70	0.098	B	18	8	22	22	8	12.5
.....	.....	....	61S-W	0.25	0.55	....	0.95	....	....	0.25	....	....	....	Quenched	2.70	0.098	B	35	21	22	22	21	24.0
.....	.....	....	61S-T	0.25	0.55	....	0.95	....	....	0.25	....	....	....	Heat-Treated	2.70	0.098	B	45	39	12	12	39	30.0
Forging Alloys																							
.....	.....	....	14S-T	4.4	0.8	0.8	0.4	....	....	....	....	....	....	H. T. & Aged	2.78	0.101	C	65	50	10.0		50	45.0
.....	.....	....	17S-T	4.0	....	0.5	0.5	....	....	....	....	....	....	H. T. & Aged	2.78	0.101	C	55	30	16.0		30	36.0
.....	.....	....	18S-T	4.0	....	....	0.5	....	2.0	....	....	....	....	H. T. & Aged	2.86	0.103	D	55	35	10.0		35	....
.....	.....	27	25S-T	4.5	0.8	0.8	....	....	....	....	....	....	....	H. T. & Aged	2.78	0.101	D	55	30	16.0		30	35.0
.....	.....	....	32S-T	0.8	12.0	....	1.0	....	0.8	....	....	....	....	H. T. & Aged	2.68	0.097	B	52	40	5.0		40	38.0
.....	.....	280	A51S-T	....	1.0	....	0.6	....	....	0.25	....	....	....	H. T. & Aged	2.68	0.097	B	44	34	14.0		34	32.0
.....	.....	....	53S-T	....	0.7	....	1.3	....	....	0.25	....	....	....	H. T. & Aged	2.68	0.097	A	36	30	16.0		30	24.0
Sand Casting Alloys																							
B26-37T	JJ	35	43	....	5.0	....	....	....	....	....	....	....	....	As Cast	2.66	0.096	B	19	9	6.0		10	14.0
B26-37T	K	37	47[1]	....	12.5	....	....	....	....	....	....	....	....	As Cast	2.65	0.096	B	26	11	8.0		11	18.0
.....	.....	...	108	4.0	3.0	....	....	....	....	....	....	....	....	As Cast	2.75	0.099	D	21	14	2.0		14	20.0
B26-37T	C	33	112	7.5	....	....	....	2.0	....	....	....	....	1.2	As Cast	2.85	0.103	D	23	14	1.5		17	20.0
B26-37T	F	34	122	10.0	....	....	0.2	....	....	....	....	....	1.2	As Cast	2.85	0.103	D	26	21	0.5		..	25.0
.....	.....	34	122-T2	10.0	....	....	0.2	....	....	....	....	....	1.2	Annealed	2.85	0.103	D	25	20	1.0		20	21.0
.....	.....	39	142	4.0	....	....	1.5	....	2.0	....	....	....	....	As Cast	2.73	0.099	D	28	24	1.0		31	24.0
B26-37T	H	39	142-T61	4.0	....	....	1.5	....	2.0	....	....	....	....	H. T. & Aged	2.73	0.099	D	37	32	0.5		47	32.0
.....	.....	...	142-T571	4.0	....	....	1.5	....	2.0	....	....	....	....	Aged	2.73	0.099	D	32	28	0.5		34	27.0
B26-37T	G	38	195-T4	4.0	....	....	....	....	....	....	....	....	....	Heat-Treated	2.77	0.100	C	31	16	8.5		16	24.0
B26-37T	G	38	195-T6	4.0	....	....	....	....	....	....	....	....	....	H. T. & Aged	2.77	0.100	C	36	22	5.0		25	30.0
B26-37T	G	38	195-T62	4.0	....	....	....	....	....	....	....	....	....	H. T. & Aged	2.77	0.100	C	40	31	2.0		38	31.0
B26-37T	CC	36	212	8.0	1.2	....	....	....	....	....	....	....	1.0	As Cast	2.83	0.102	D	22	14	2.0		14	20.0
B26-37T	L	320	214	....	....	....	3.8	....	....	....	....	....	....	As Cast	2.63	0.095	A	25	12	9.0		12	20.0
.....	.....	324	220-T4	....	....	....	10.0	....	....	....	....	....	....	Heat-Treated	2.56	0.092	A	45	25	14.0		26	33.0
.....	.....	...	A334	3.0	4.0	....	0.3	....	....	....	....	....	....	As Cast	2.73	0.099	D	25	16	2.0		22	24.0
B26-37T	N	322	355-T4	1.3	5.0	....	0.5	....	....	....	....	....	....	Heat-Treated	2.68	0.097	C	30	20	5.0		23	28.0
B26-37T	N	322	355-T6	1.3	5.0	....	0.5	....	....	....	....	....	....	H. T. & Aged	2.68	0.097	C	35	25	3.5		37	30.0
B26-37T	N	....	355-T51	1.3	5.0	....	0.5	....	....	....	....	....	....	Aged	2.68	0.097	C	28	23	1.5		24	22.0
.....	.....	....	A355-T51	1.4	5.0	0.8	0.5	....	0.8	....	....	....	....	Aged	2.71	0.098	C	28	24	1.5		24	22.0
.....	.....	....	A355-T59	1.4	5.0	0.8	0.5	....	0.8	....	....	....	....	Aged	2.71	0.098	C	25	21	2.0		21	21.0
B26-37T	M	323	356-T4	....	7.0	....	0.3	....	....	....	....	....	....	Heat-Treated	2.65	0.096	B	28	16	6.0		18	22.0
B26-37T	M	323	356-T6	....	7.0	....	0.3	....	....	....	....	....	....	H. T. & Aged	2.65	0.096	B	32	22	4.0		22	27.0
.....	.....	323	356-T51	....	7.0	....	0.3	....	....	....	....	....	....	Aged	2.65	0.096	B	25	20	2.0		22	18.0
.....	.....	31	645	2.5	....	....	....	11.0	....	....	....	....	1.2	As Cast	2.94	0.106	D	29	20	4.0		20	22.0
Permanent Mold Casting Alloys																							
B108-38T	9A	35	43	....	5.0	....	....	....	....	....	....	....	....	As Cast	2.68	0.097	B	24	9	6.0		9	18.0
B108-38T	3	....	A108	4.5	5.5	....	....	....	....	....	....	....	....	As Cast	2.77	0.100	D	28	16	2.0		16	25.0
.....	.....	33	112	7.5	....	....	....	2.0	....	....	....	....	1.2	As Cast	....	0.104	D	27	19	1.5		19	23.0
.....	.....	....	B113	7.0	1.7	....	....	....	....	....	....	....	1.2	As Cast	2.86	0.103	D	28	19	2.0		19	23.0
B108-38T	2	....	C113	7.0	4.0	....	....	2.0	....	....	....	....	1.2	As Cast	2.86	0.103	D	30	24	1.0		24	22.0
.....	.....	34	122-T52	10.0	....	....	0.2	....	....	....	....	....	1.2	H. T. & Aged	....	0.104	D	35	31	0.5		31	25.0
B108-38T	6	....	A132-T4	0.8	12.0	....	1.0	....	2.5	....	....	....	0.8	H. T. & Aged	....	0.097	C	38	30	1.5		30	29.0
B108-38T	6	....	A132-T551	0.8	12.0	....	1.0	....	2.5	....	....	....	0.8	H. T. & Aged	....	0.097	C	36	28	0.5		30	24.0
B108-38T	5	....	138	10.0	4.0	....	0.2	....	....	....	....	....	1.4	As Cast	....	0.105	D	28	24	0.5		32	22.0
.....	.....	39	142	4.0	....	....	1.5	....	2.0	....	....	....	....	As Cast	2.77	0.100	C	34	24	1.0		26	24.0
B108-38T	11	39	142-T61	4.0	....	....	1.5	....	2.0	....	....	....	....	H. T. & Aged	....	0.100	C	47	42	0.5		46	31.0
B108-38T	11	39	142-T571	4.0	....	....	1.5	....	2.0	....	....	....	....	H. T. & Aged	....	0.100	C	40	34	0.0		34	26.0
B108-38T	1	....	B195-T4	4.5	3.0	....	....	....	....	....	....	....	....	H. T. & Aged	....	0.101	C	36	22	7.5		22	30.0
.....	.....	....	B195-T6	4.5	3.0	....	....	....	....	....	....	....	....	H. T. & Aged	....	0.101	C	39	33	5.0		33	32.0
.....	.....	....	A214	....	....	....	3.8	1.8	....	....	....	....	....	As Cast	2.68	0.096	B	27	16	5.0		17	22.0
.....	.....	322	355-T4	1.3	5.0	....	0.5	....	....	....	....	....	....	H. T. & Aged	....	0.097	C	38	23	6.0		23	29.0
.....	.....	322	355-T6	1.3	5.0	....	0.5	....	....	....	....	....	....	H. T. & Aged	....	0.097	C	43	26	4.0		26	30.0
Die-Casting Alloys																							
B85-39T	V	305	13	....	12.0	....	....	....	....	....	....	....	....	As Cast	2.66	0.096	B	33	18	1.8		..	....
B85-39T	IV	304	43	....	5.0	....	....	....	....	....	....	....	....	As Cast	2.68	0.097	B	29	13	3.5		..	....
B85-39T	XII	312	81	7.0	3.0	....	....	....	....	....	....	....	....	As Cast	2.85	0.103	D	32	24	1.3		..	....
B85-39T	VI	....	83	2.0	3.0	....	....	....	....	....	....	....	....	As Cast	2.75	0.099	C	30	14	3.5		..	....
B85-39T	VII	307	85	4.0	5.0	....	....	....	....	....	....	....	....	As Cast	2.78	0.101	C	35	19	2.7		..	....
.....	.....	...	218	....	....	....	8.0	....	....	....	....	....	....	As Cast	2.53	0.091	A	36	23	5.0		..	....

NOTES:

[1] Properties of Alcoa Alloy No. 47 are obtained by special foundry practice called "modification."

[2] For all Alcoa alloys, wrought and cast, the following data apply: (a) Young's modulus of elasticity may be taken as 10,300,000 lb. per sq. in.; (b) Modulus of rigidity may be taken as 3,800,000 lb. per sq. in.; (c) Poisson's ratio is 0.33; (d) Bearing strength is equal to 1.8 times the tensile strength, provided the edge distance, in the direction of stressing, is not less than twice the diameter of the hole.

[3] Yield strength is the stress at which the material exhibits a permanent set of 0.2 per cent.

[4] Mechanical properties are obtained on A.S.-T.M. specimens. Since minimum guaranteed values vary with the commodity, these values are not given.

[5] Shearing strengths are single-shear values obtained from double-shear tests.

[6] Fatigue endurance values are based on withstanding 500 million cycles of completely reversed stress using the R. R. Moore type of machine and specimen.

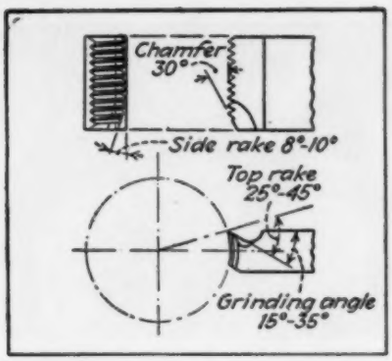
[7] An "A" rating is highest. Rating compares the stability of all aluminum-base alloys as a group, and is based on results of standard salt-

BASE ALLOYS

Fatigue Endurance Limit[4] (1,000 lb. per sq. in.)	Brinell Hardness (500 kg. load on 10 mm. ball)	Relative Suitability for Being Cold Worked[5]	Relative Suitability for Being Welded[3]		Relative Suitability for Being Brazed[3]	Relative Machinability[3]
			Gas and Arc	Resistance		
5.0	23	A	A	A	A	B
8.5	44	C	A	A	A	B
7.0	28	A	A	A	A	B
10.0	55	C	A	A	A	B
12.5	95	C	D	B	D	A
....	100	C	D	B	D	A
11.0	45	A	D	D	D	B
15.0	100	C	D	D	D	A
13.5	70	C	..	..	..	A
12.0	42	A	D	D	D	B
18.0	105	C	D	D	D	A
....	116	D	D	D	D	A
17.0	45	A	B	A	D	B
20.5	85	C	B	A	D	B
7.5	26	A	A	B	D	B
10.0	65	B	A	B	D	B
11.0	80	C	A	B	D	B
8.0	30	A	A	B	A	B
12.5	65	B	A	B	A	B
12.5	95	C	A	B	A	B
16.0	130	..	..	..	..	A
15.0	100	..	..	..	..	A
....	100	..	..	..	..	A
15.0	100	..	..	..	..	B
14.0	115	..	..	..	..	B
10.5	90	..	..	..	..	B
11.0	75	..	..	..	..	B
6.5	40	..	A	..	..	B
6.0	50	..	A	..	..	C
8.5	55	..	B	..	..	B
9.0	70	..	B	..	..	B
9.5	85	..	C	..	..	..
9.5	75	..	C	..	..	B
8.0	80	..	C	..	..	..
8.0	100	..	C	..	..	B
8.0	85	..	C	..	..	B
6.0	65	..	C	..	..	B
6.5	80	..	C	..	..	B
7.0	95	..	C	..	..	B
8.0	65	..	B	..	..	B
7.0	50	..	D	..	..	B
7.0	75	..	D	..	..	B
8.5	65	..	A	..	..	B
....	60	..	A	..	..	B
....	80	..	A	..	..	B
7.0	60	..	A	..	..	B
7.0	65	..	A	..	..	B
8.0	60	..	A	..	..	B
....	55	..	A	..	..	B
8.0	70	..	A	..	..	B
6.0	60	..	A	..	..	B
7.5	70	..	C	..	..	B
....	40	..	A	..	..	B
....	60	..	A	..	..	B
....	65	..	B	..	..	B
....	70	..	B	..	..	B
....	80	..	B	..	..	B
....	105	..	..	..	..	B
....	100	..	..	..	..	B
....	105	..	..	..	..	B
....	100	..	..	..	..	B
....	105	..	..	..	..	B
9.5	110	..	..	..	..	B
....	105	..	..	..	..	B
9.5	65	..	B	..	..	B
....	90	..	B	..	..	B
....	60	..	D	..	..	B
....	60	..	..	..	..	B
....	75	..	..	..	..	B
15.0	..	..	..	..	..	B
....	..	..	..	..	..	B
16.0	..	..	..	..	..	B
14.5	..	..	..	..	..	B
17.0	..	..	..	..	..	B
17.0	..	..	..	..	..	B

spray tests. However, under many conditions, alloys rated "D" are used with entirely satisfactory results; on the other hand, alloys rated "A" require protection in some exposures.

[3] Relative hot and cold workability, weldability, brazeability and machinability are indicated as follows: A = Excellent, B = Good, C = Fair, and D = Poor. Ratings are based on aluminum-base alloys as a group and are not to be used in comparison with other metals.



Thread chasers for self-opening die heads and collapsible taps should be ground as shown. Top rake angle should be greater for soft alloys and less for hard alloys

150 ft. per min. in larger sizes work well when the reamer is ground the same as for cast iron.

THREADING

Single-point threading of aluminum and aluminum alloys is an easy operation when the threading tool has considerable top and side rake and is fed into the work at a 30 deg. angle. When using a die head for threading these alloys, the chasers should be ground with a radial hook or sharp rake angle, particularly if the material is tough and stringy. Milled-thread die chasers for cast alloys generally are ground with a 5 to 10 deg. radial hook or rake angle for straight threading. A rake angle of 25 to 30 deg. works well with wrought alloys. Lapped chasers in threading dies produce smoother threads. Threading speeds range from 50 to 100 ft. per min. for standard threads. Special forms usually are cut at 20 ft. per min. As aluminum is comparatively soft, it is important that the die head be in proper alignment with the work when threading.

TAPPING

Hard surface-treated high-speed steel taps, with ground threads and highly polished flutes, a 5 to 18 deg. hook on the cutting edge, and about a 5 deg. hook on the heel, depending on the size of the tap, seem to operate best in aluminum. In sizes up to ½ in., taps with three flutes provide more chip space. In cast aluminum, the cutting face of the tap should be altered from a hooked cutting face to a straight rake. Suggested speeds range from 60 to 100 ft. per min.

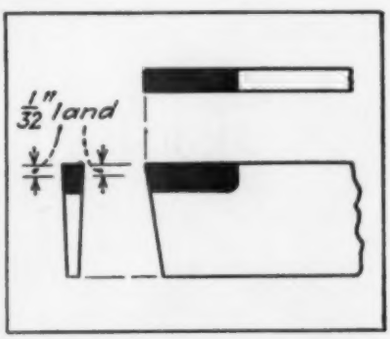
Application of proper cutting fluids will result in better size control, smoother and more accurate threads, with less tap sharpening. It is desirable to force the lubricant into the hole under pressure and parallel to the axis of the tap where conditions permit such an arrangement. This will facilitate chip removal. It is essential that there be sufficient space in the flute for the chips. Some users claim that helical-flute taps are unnecessary, except when tapping blind holes, or holes having a slot, providing the straight-flute taps are properly designed.

FILING

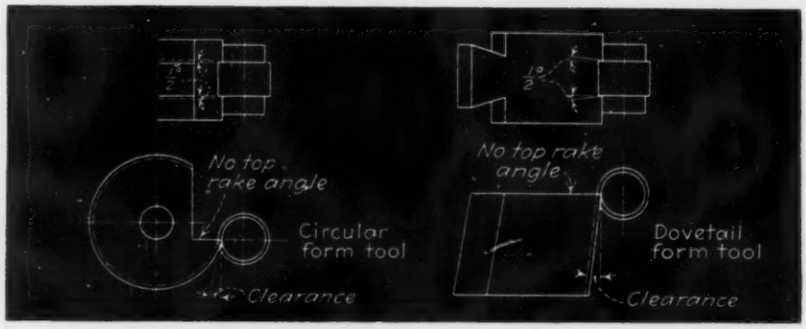
Where a considerable amount of stock is to be removed, a curved tooth file with coarse deeply cut teeth is recommended. For finish filing, especially on small work, a long-angle lathe file with 14 to 20 teeth per inch should be used. This file has a side rake of 45 to 55 deg., thus giving a more efficient cutting edge than can be obtained with single-cut files having a smaller side rake. The long angle helps force filings from the teeth. Chromium plating, if properly applied, will cause a file to work better, since the cuttings will not adhere to the plating surface. Rubbing chalk over file teeth or oiling them often helps prevent loading.

SAWING

Principles which govern design of cutting tools for aluminum and its alloys should be followed in selecting proper saws. Comparatively coarse teeth with curved gullets cut well. The teeth should be free from sharp corners and burred edges to reduce the possibility of chips stocking in the teeth. Alternate side-rake saws, or those having "chip-breaker" teeth may be used. For either type, a top rake or a "hook" of 10 to 25 deg.



Tipped with tantalum-tungsten carbide, this grooving tool is recommended for automotive pistons and similar work by Vascoloy-Ramet



Form tools used on screw machines ordinarily have no back rake and are made with a one-half degree side clearance

will give the best cutting action. Clearance of saw teeth is important; otherwise, the sides or the tips of the teeth will drag and so generate heat.

Circular saws for aluminum may be operated at peripheral speed of 10,000 to 15,000 ft. per min. Comparatively high speeds also are recommended for bandsaws. A fine feed should be used to avoid large cuttings. Tungsten carbide tipped saws are recommended for cutting aluminum alloys which contain substantial amounts of silicon.

Tooth spacing in bandsaws usually is about 4 or 5 teeth to the inch in the "hardened throughout" type, and either 6 or 8 teeth to the inch in the "flexible back" type. Hacksaw blades of the "wavy-set" type are satisfactory for cutting aluminum by hand, and the "curled chip" type is satisfactory for power hacksaw cutting. A cutting lubricant is necessary for some classes of work, such as cutting large heavy sections.

GRINDING

Wheel speeds above 6,000 ft. per min. have given good results when using silicon carbide wheels, but both wheel and work speeds should be set for the job at hand by an experienced operator. A solution of soluble cutting oil and water works well as a grinding compound. It is important that the fine grindings of aluminum be strained from the compound before reusing, in order to prevent deep scratches on the finished surface. For high finishes a slightly higher work speed than normal should be employed. Normal table traverse speeds should be used for roughing operations, but for the final finishing operation, the slower the table traverse speed the better.

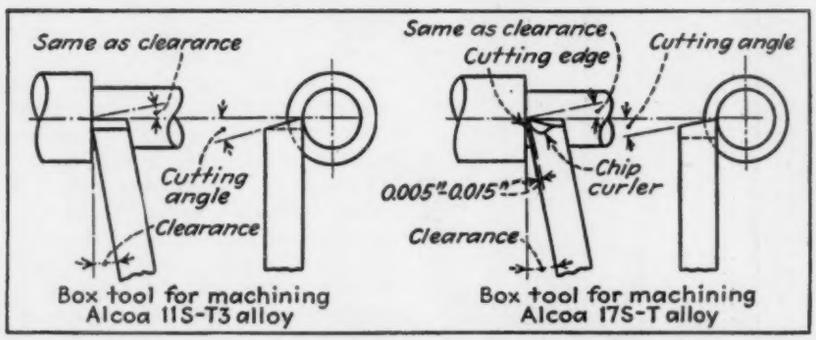
Generally speaking, a mechanical wheel dresser will work more satisfactorily than a diamond when aluminum or its alloys are being ground. It has been found that if the wheel is treated lightly with beeswax after truing, there is less tendency of the wheel to load with aluminum. The use of kerosene as a grinding coolant also helps to prevent loading.

CUTTING LUBRICANTS

Machining operations can be carried out successfully on some aluminum alloys without any lubricant or cutting compound; however, for best results some form of lubricant is desirable. Mineral-base lubricating oils thinned with kerosene frequently are used for most machining operations. It is reported that a number of plants are finding fuel oil satisfactory.

The nature of most machining operations or aluminum alloys makes it necessary that the cutting coolant employed be able to absorb the heat developed in the cutting operation. A light viscosity paraffin oil, kerosene, or a mixture of these two and a fatty oil, will leave a desirable finish. On some difficult threading operations, it has been found that small amounts of a sulphurized cutting oil, blended with a light paraffin oil, or used straight, will produce very smooth, high quality threads.

Beeswax may be used for tapping and threading. A mixture of beeswax, gasoline and turpentine made up into a paste works well for these operations. The use of turpentine is not advisable, since when the liquid evaporates it leaves a resinous deposit on the work. Soapy water gives good results in machining most of the aluminum alloys.



Box tool holders for screw machines hole blades at clearance angle of 8 deg. A notched cam helps break up chips under heavy cuts

JOINING PRACTICES FOR ALUMINUM

Both welding and brazing, as well as mechanical joining methods such as riveting and bolting, are employed in the fabrication of aluminum alloy structures. Choice of process depends on alloy used, stresses involved and service requirements. The technique for welding aluminum and its alloys is much the same as that employed for other common metals. Both fusion welding, in the form of torch and arc welding, and resistance welding, are used extensively in industry.

RIVETING

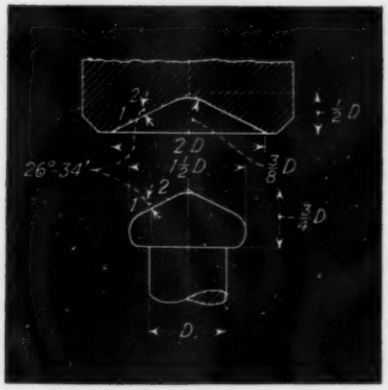
Riveting still is the most common method of joining aluminum, especially the heat-treatable alloys which depend on thermal treatment to develop high mechanical properties and, consequently, cannot be welded without sacrifice in strength. Riveting operation ordinarily is done cold. There should be clearance between rivet and rivet hole to allow for spread on heading up. It is important that a line of rivets should *not* be put in by working across the line consecutively from one rivet to the next.

Aluminum alloy rivets may be driven with squeeze riveters, or with hand or pneumatic hammers. No

matter which method is used, more pressure is required to drive the strong aluminum alloy rivets than is necessary to head hot steel rivets. Too light a blow will have a peening action on the rivet, and will not expand the shank in the hole.

The cone point driven head shown is recommended for aluminum alloy rivets. This head is large enough to develop the tensile strength of the rivet shank in a straight tensile pull, yet requires less driving pressure than a full button head. Degree of upsetting for the cone-point head is best controlled by checking diameters of driven heads, keeping them close to 1.5 times nominal shank diameter.

Rivet sets for aluminum alloy rivets should be smooth, polished surfaces, so that the metal may flow readily during forming. Bucking tools, espe-



The cone-point driven head is recommended for aluminum-alloy rivets, as it needs less pressure

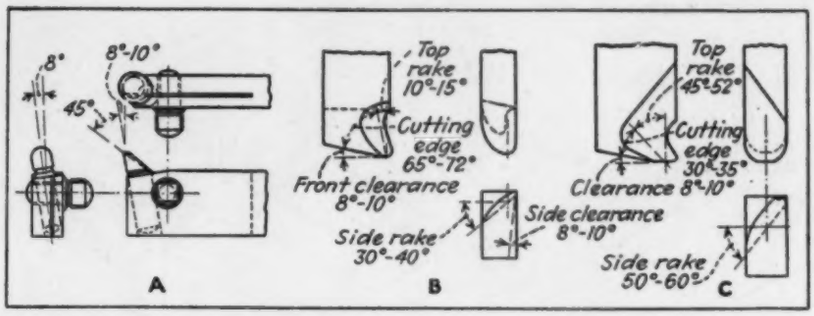
cially those used with the larger hammers, should have plenty of mass. Cup on bucking-up set should be slightly wider and shallower than the manufactured head, so that the initial contact will be at the end of the head, directly in line with the shank.

SOLDERING

Zinc- and tin-base solders can be used for aluminum and its light alloys, but the joints are subject to electrolytic corrosion unless adequately protected from moisture. For permanence, welding usually is preferred. The soldering of aluminum is better understood now than a few years ago, and this method of joining now has some applications for which it is satisfactory.

One procedure is to "tin" each of the surfaces to be joined by cleaning the surface thoroughly and heating it slightly above the melting point of the solder, then melting a small amount of solder on the surface and rubbing with a wire brush. After tinning, the two parts are reheated, a little more solder is added if necessary, and the parts are pressed tightly together while still hot.

There now is available a solder and an Alcoa soldering flux which can be used to join aluminum and many of its alloys when using the soldering techniques commonly employed with other metals.



A change in holder adapts the inserted-bit turning tool for planer and shaper applications as shown at A. *Solid tools shown at* B *and* C *work well for roughing and finishing operations*

TORCH WELDING

Fusion welding with the oxyacetylene or oxyhydrogen torch is applicable for making articles from basic wrought and cast alloys, and for the repair of aluminum alloy castings. The oxyhydrogen flame generally produces a cleaner and more satisfactory joint. It usually will give sufficient heat for welding metal up to ⅜ in. in thickness. Whether using hydrogen or acetylene, the torch should be adjusted carefully to show a neutral flame. This gives the best speed and economy, as well as a cleaner and sounder weld.

Production of a sound weld in aluminum involves the removal of the thin oxide film which otherwise prevents proper coalescing of the two surfaces of molten metal. This refractory film can be removed mechanically, or by the action of a suitable flux. Fluxes in general use are mixtures of salts, such as the chlorides, fluorides, and sulphates of sodium, potassium, lithium, calcium and aluminum in varying amounts.

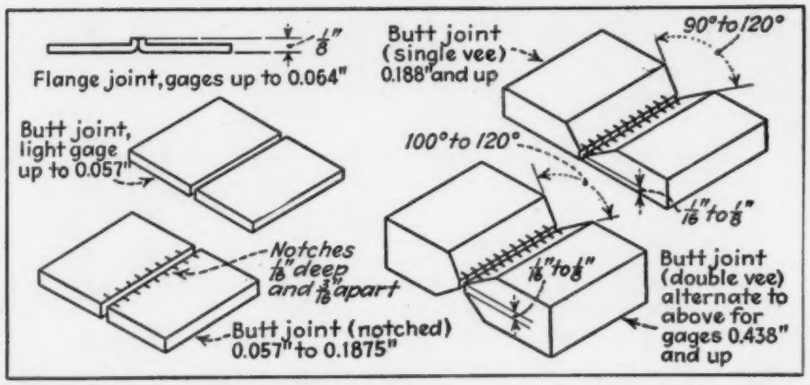
Proper selection of the welding rod is essential. Commercially pure aluminum and aluminum-manganese alloys ordinarily should be welded with pure aluminum wire, or with a rod of the same composition as the alloy. The parts being welded should be free to expand and contract during the welding operation. On other alloys and parts held in jigs, so that they are not free to move, an aluminum alloy rod containing 5 per cent silicon should be used.

Aluminum sheet ⅜ in. or more in thickness, and large aluminum castings, should be preheated to 700 or 800 F. in order to avoid heat strains and to reduce the amount of oxygen and acetylene required for melting the seam. Also, if the base metal for some distance on either side of the seam is maintained at a temperature slightly below its melting point, the additional expansion caused by application of the torch is less likely to cause distortion of the work.

As soon as the torch weld is completed and the work has had time to cool, it should be washed thoroughly to remove all traces of flux. Most parts can be cleaned in boiling water if the joint can be reached with a brush. For inaccessible welds, cleaning can be done by first washing in hot water,

WHEELS RECOMMENDED FOR GRINDING ALUMINUM ALLOYS

Operation	*Abrasive Type*	*Abrasive Grit Size*	*Grade*	*Process*	*Wheel Speed Ft. Per Min.*
Snagging	Aluminum Oxide	20–36	Medium	Resinoid	5,000– 9,500
Cylindrical	Silicon Carbide	36–46	Soft	Vitrified	5,000– 6,000
Surfacing (cups or cylinders)	Silicon Carbide	24–30	Soft	Vitrified	4,500– 5,000
Internal	Silicon Carbide	36–46	Soft	Vitrified	5,000– 6,000
Cutting Off:					
Tubing and molding	Aluminum Oxide	80–120	Very Hard	Rubber	9,000–10,500
Gates and risers	Aluminum Oxide	24	Very Hard	Rubber	9,000–16,000



The above methods of preparing joints serve well when torch welding aluminum alloys. When using the metallic arc process, no preparation of the joint is necessary on sheet up to ¼ in. thick; the edges should be beveled to form a 90 deg. V with a ⅛ in. lip on thicker material

then immersing the part in a cold solution of 10 per cent sulphuric acid for 30 min. or in a 5 per cent solution of sulphuric acid held at 150 F. for 10 min.

In general, the technique of handling the torch, adjusting the flame and tip size is practically the same for torch welding heat-treatable alloys, as for the non-heat-treatable alloys. Often, where heat-treatable alloy parts are to be jig welded, it is best to tack weld and then loosen the jig clamps before completing the seam. In other cases it is sufficient merely to loosen the clamps immediately after completing the joint. Welding should be done in one pass.

ARC WELDING

The metallic arc welding process is particularly applicable in certain classes of work, since there is less buckling and warping of the work with arc welding than with torch welding. Preheating before welding can be eliminated to a large extent. Temper of the sheet is less affected during arc welding than during torch welding, since the heat is more concentrated and the weld is made more rapidly.

Metallic arc welding can be accomplished only with flux-coated electrodes. Such electrodes usually contain a filler wire composed of 95 per cent aluminum and 5 per cent silicon. Electrodes should not be stored for periods longer than six months. Excessive spatter of the arc when electrodes are used usually is caused by moisture in the flux coating. When this occurs the electrodes should be dried at a temperature between 200 and 300 F. for three or four hours.

For metallic arc welding of aluminum alloys, a steep volt-amp curve should be used. Both a.c. and d.c. arc welding machines are suitable. In setting up, the electrode usually is connected positive and the work negative. Ordinarily, a short arc is held. In starting an electrode, best results are obtained by "scratching" the electrode because, in some cases, the flux becomes fused over the striking end.

Should it be necessary to stop welding before a joint is completed, the slag must be removed from the crater and for a distance of approximately 1 in. beyond the crater before striking another arc. The new electrode is struck in the crater and the electrode is moved quickly back along the completed weld for about ½ in., and then welding proceeds as usual, making sure that the crater is completely remelted.

Best results ordinarily are obtained by using high currents and a high welding speed. Very little heat is dissipated into the base plate, consequently the molten metal is chilled and there may be some porosity along or just outside the line of fusion. If the plates are heated for some distance on either side to a temperature of 600 F., this porosity can be reduced or eliminated.

For butt welds, the work should be held in position by jig clamps and should be backed up by a copper plate. When butt-welding plates more than ⅛ in. thick, the copper backing plate should be grooved slightly beneath the joint to be welded. When making lap fillet welds, the general procedure is the same as that outlined above, except that the electrode should be manipulated with a small rotary motion, playing the arc first on the upper member, and then on the lower member of the joint.

Because of the manner in which a carbon arc weld is made, the process is not so generally applicable for welding aluminum and its alloys as is the metallic arc process. In general, its use is confined to butt joints and simple lap joints. In this process, the flux-coated welding rod is placed between the joint to be welded and the carbon electrode. Welding heat then is transmitted through the rod to the edges of the joint.

RESISTANCE WELDING

Resistance welding of aluminum and its alloys has been considered possible only during the past few years, but is already taking its place as an important fabricating process. The more commonly employed forms are spot, seam or line, and butt welding. It is important, from the standpoint of cost, that the oxide coating be removed, just before spot welding, so that surface heating will not occur when contact is made with welding electrodes.

Surfaces may be cleaned for spot welding in several ways. A fine grade of abrasive cloth, fine steel wool, or a fine scratch brush may be used when only a few parts are involved. Only the area contacted by the welding tips need be cleaned, except in cases where the parts have been heat-treated in nitrate; then it is desirable to clean one or both of the faying surfaces. The surfaces also may be cleaned with an etching solution.

During spot-welding, a molten zone is formed over a small area between the two aluminum sheets, directly between the electrodes. In order to keep pressure on this area at a minimum, one or both of the electrodes should establish only a point contact on its sheet. The conical point commonly employed has an included angle of 158 to 166 deg. Most spot-welding machines designed for other materials are not suited for use with aluminum alloys, since they do not provide a sufficiently high welding current for the work.

BRAZING

Methods of brazing aluminum alloy assemblies, announced only a year ago, make possible neat joints that require little finishing and cost less than gas or metallic arc welded joints in aluminum and its alloys. These processes employ certain low-melting point, aluminum-base alloys as a filler material, and a special flux which permits the filler to wet the surfaces of the joint. At present, brazing of aluminum alloy assemblies has been done by the furnace, torch and dip brazing methods.

A temperature range of 1,000 to 1,200 F. is suitable for most applications of furnace brazing. In this process, parts are assembled, fluxed, placed in the furnace, and raised to a temperature above the melting point of the filler material, but below the melting point of the part to be joined. Temperature control within 5 to 10 F. of the nominal value is essential for consistent results. In furnace brazing, the brazing alloy must be placed right at the joint before the assembly goes into the furnace. Clearance in the joint to be brazed is from 0.004 to 0.008 in.

Generally, it is sufficient to coat only the brazing alloy with flux, but in some cases best results are obtained by coating both the filler material and the part to be joined. When the furnace brazing operation has been completed, the coating of flux over and around the brazed joint must be removed to prevent attack of the metal if the part is to be used in contact with water.

FINISHES FOR ALUMINUM

For some products the "as-cast" and "as-worked" surface appearance natural to aluminum and aluminum alloy commodities are quite satisfactory. Often, however, it is desirable to apply one or more types of finish to the material in order to enhance its appearance, to increase its resistance to corrosion, and to protect the surface from abrasion. Finishes for aluminum and its alloys may be divided into four general classes, depending upon the manner in which they are applied. These are: (1) mechanical finishes, (2) chemical finishes, (3) electrochemical finishes, and (4) paint and lacquer finishes.

MECHANICAL FINISHES

By means of various mechanical finishes, the surface of an aluminum part can be freed from irregularities or scratches and, if desired, brought to a high lustre. Both hand and automatic mechanical equipment are used. Both portable and stationary tools are used for "snagging" castings and for removing large defects from aluminum parts by grinding. These rough-grinding operations can be done dry, but tallow or lard oil may be used when the operation requires. For most rough polishing, wheel speeds of 5,000 to 9,500 ft. per min. are used.

In general, polishing is accomplished in four steps: (1) roughing, (2) greasing or oiling, (3) buffing, and (4) coloring. The first two operations remove scratches and blemishes from the surface and prepare it for buffing. If the surface is smooth, it may be possible to eliminate either one or both of these operations. The four polishing operations differ primarily in the composition of the wheels, the abrasives, the methods by which the abrasives are applied, the speed at which the wheels operate, and the use of lubricants.

The high luster finish on the different types of aluminum is obtained by the two buffing operations. The first or "cutting down" operation differs from roughing and greasing in that the abrasive is imbedded in a grease binder and rubbed on instead of being glued to the face of the wheel. The final polishing operation, "coloring," usually is done with a loose wheel (made up of unsewed muslin or flannel disks), and the abrasive consists of lime or soft silica in a grease binder. Peripheral speeds may vary from 7,500 to 10,000 ft. per min.

A coarse lined scratch-brush finish may be obtained by the application of a rotating wire brush to the aluminum surface. Fineness of finish may be regulated by the size of the wires used in the brush. Dirt and grease first must be removed from the aluminum surface by rubbing it with air-slacked lime. Then it is held lightly against the edge of the revolving wire brush until the desired roughness is obtained. Ordinarily, low wheel speeds are used in order to eliminate excessive tearing of the metal surface. Satin finish is a modification of the scratch brush finish obtained by treatment of the metal with a finer wire brush wheel or by abrasives. Various effects may be obtained by changing the angle of contact of the surface with the wire brush.

Sandblasting is a rapid and inexpensive method for finishing aluminum. It gives a uniform matte surface appropriate for some articles. Usually, it is desirable to protect the sand-blasted surface by a lacquer or a clear varnish coating. Washed silica sand probably is the most commonly used abrasive for sand blasting aluminum. During the blasting, the nozzle is held at from 12 to 20 in. from the work and at an angle of 60 to 90 deg. with the surface. Motion of the nozzle in blasting should be in parallel lines extending the full length of the work.

Tumbling and burnishing operations frequently will produce a satisfactory finish. Burnishing produces a bright, fairly smooth surface by the action of steel shot rubbing against the parts. It is accomplished by tumbling the work together with the shot in a wood-lined barrel. Soap and water are added as a lubricant. For general work, $\frac{3}{32}$-in. steel balls are satisfactory, although other shapes such as cones, pins, slugs and disks may be used for special purposes.

CHEMICAL FINISHES

Low-cost protective and decorative finishes resistant to corrosion, but not particularly resistant to abrasion, can be obtained chemically. Such finishing methods include the frosted, chemical etching, and "Alrok" finishes.

The frosted finish has a silvery ap-

TYPICAL POLISHING PROCEDURES FOR ALUMINUM

Article	*Operation*	*Wheel*	*Composition*
SHEET COOKING UTENSILS	1. Buffing	Sewed muslin buff	Tripoli
	2. Coloring	Open muslin buff	Soft silica
SCREW-MACHINE PRODUCTS	1. Greasing	Felt or sheepskin	No. 180 emery
	2. Buffing	Sewed muslin buff	Tripoli
	3. Coloring	Open muslin buff	Soft silica
DIE CASTINGS	1. Greasing*	Glued rag wheel	No. 100 emery
	2. Greasing*	Felt wheel	No. 150 emery
	3. Buffing	Sewed muslin buff	Tripoli
	4. Coloring	Open muslin buff	Soft silica
SAND CASTINGS	1. Roughing	Glued rag wheel	No. 70 to 100 emery
	2. Greasing	Glued rag wheel	No. 100 to 220 emery
	3. Buffing	Sewed muslin buff	Tripoli
	4. Coloring	Open muslin buff	Lime

*May omit one or both.

pearance like that of finely etched glass, and is useful for finishing small or intricately shaped parts. It is not a permanent finish and needs further protection. The first step is to etch in a hot caustic soda solution. Immersion for 1 min. in a 15 per cent sodium hydroxide solution at 160-180 F. is frequently employed, although the concentration may vary from 2 to 25 per cent, and the bath may be heated to boiling. After etching, the metal is rinsed in clear cold water. If the time between the two steps is kept at a minimum, any liquid on the surface dries uniformly, and the danger of staining is minimized. Cold water is preferable to hot water, because it, too, lessens discoloration.

The third step is to immerse in strong nitric acid to neutralize any sodium hydroxide left on the surface. A satisfactory solution is made by mixing two parts of concentrated nitric acid with one part of water. However, concentrations as low as ten per cent are sometimes used. Following the nitric acid dip, the article is rinsed in clear, cold water, and then dried on a steam table.

ELECTROLYTIC FINISHES

The oxide finishes formed by anodic treatment in various electrolytes comprise one of the most important classes of finishes for aluminum. The hard corundum-like anodic coatings, which can be formed only on aluminum, are among the most durable of known finishes, and give protection and permanence to the surface. They are attractive in appearance, have high resistance to corrosion, high dielectric strength, high reflectivity, and good absorption for dyes and mineral pigments. Properties of the coatings vary, depending on the composition of the alloy, the composition of the electrolyte, and the temperature and voltage of operation, as well as the time of treatment. The patented "Alumilite" process is the most practical of the anodic treatments. It comprises anodic treatment of aluminum in a suitable electrolyte to secure a dense, adherent coating of aluminum oxide.

Electroplates on aluminum, such as bright chromium, nickel and oxidized copper, brass and silver, are used primarily for their appearance and the resistance to wear which they afford. These electroplates, while they are perfectly satisfactory where the corrosion conditions are not too severe, may not be satisfactory for continuous outdoor exposure.

Chromium applied directly on aluminum has several desirable characteristics. The coatings are ornamental, have high resistance to abrasion and resist alkaline solutions particularly well. Zinc electroplated on aluminum has been used to improve the electrical contact characteristics of the aluminum surface. Zinc or cadmium electroplates have also been used to increase the life of aluminum in certain corrosive environments.

The solutions and technique employed for electroplating on aluminum are much the same as for other metals. The important difference lies in the surface preparation before plating. Aluminum and aluminum alloys require special surface treatment if the electroplate is to show good adhesion or service, particularly where there is occasional exposure to moisture.

PAINTS AND LACQUERS

The use of paint or lacquer finishes on aluminum may be found desirable, or even necessary, for certain applications. In some instances, paint constitutes the most economical type of decoration that can be employed, while in other cases its use is desirable from the standpoint of protection, especially where severe conditions of exposure are encountered.

When a paint or lacquer coating is to be employed solely for decoration, very little special preparation is needed. The surface must, of course, be clean and free from grease if satisfactory adhesion is to be obtained. Often a thorough cleaning with solvent is sufficient.

When painting is done for protection, greater precautions must be taken, just as in the case of other metals. Adequate preparation of the surface is important, as is the selection of a satisfactory primer. Different alloys of aluminum behave somewhat differently with respect to their ability to hold paint, but in all cases aluminum alloys are easier to protect with paint than are most other metals.

One of the most effective of the simple chemical treatments employs a dilute aqueous solution of phosphoric acid. These solutions usually contain alcohol or other organic solvents in addition to phosphoric acid; sometimes chromates are added. Apparently they form a thin film of aluminum phosphate on the surface, which is quite inert and which tends to protect the aluminum and promote paint adhesion. There is a variety of proprietary treatments of this type available. Where simple cleaning of the aluminum is sufficient, inhibited alkaline solutions of the sodium phosphate type are frequently employed.

Alrok coatings, which are applied by a chemical treatment method, provide an excellent base for the application of paint. In combination with a suitable painting system, they make an excellent surface finish where the structure is to be subjected to severe exposure conditions, particularly continued high humidity or intermittent immersion in water. For severe service of this type, some of the anodic coatings are even better. The Alumilite finishes provide corrosion-resistant, adherent, impervious oxide films which constitute ideal bases for paint.

Brushing, dipping and spraying methods of applying paint finishes may be employed with aluminum. In addition, application by roller coating is particularly advantageous, especially where the metal is to be subsequently formed into various shapes. While it is not necessary to employ any special painting practice for applying decorative coatings to aluminum, a carefully selected painting system must be employed for protective coatings. The value of the system will depend to a large extent on the selection of the proper primer. The primer should have good resistance to moisture penetration to prevent surface reactions, should adhere well, form a good base for second coats, and should contain an inhibitive pigment.

Once the primer is properly applied, almost any durable exterior paint or enamel may be employed for the finishing operation. These include oil base paints, long oil varnishes and enamels, synthetic resin finishes, and aluminum paint made either with a long oil varnish or with a synthetic resin varnish. The synthetic resin enamels have been found effective as finishing coats because of their durability. Bituminous paints may also be used for finishing aluminum, but a primer of the same material is recommended in this case.

Much of the available data concerning the characteristics, applications and common methods of fabricating aluminum-base alloys has been summarized in this discussion. No attempt has been made to list all of the alloys available, those selected being typical alloys of wide application. Part of the data used has appeared in the Metals Handbook, 1939 edition, published by the American Society for Metals; in the 1940 S.A.E. Handbook published by the Society of Automotive Engineers; in specifications published by the American Society for Testing Materials; and in literature of companies which have cooperated in the preparation of this material. Reference sources consulted include Mark's Mechanical Engineers' Handbook, American Machinists' Handbook, Kent's Mechanical Engineers' Handbook, "The Metallurgy of Aluminum and Aluminum Alloys" by Robert J. Anderson, "The Aluminum Industry" by Junius D. Edwards, Francis C. Frary and Zay Jeffries, and Johnson's Materials of Construction, eighth edition.

Selection of V-Belts

RATINGS of V-belts have recently been revised by the industry to provide more uniform belt life with most economical installation cost. It has been known that the size of sheaves had an effect on the life of the V-belt but radically different results were obtained in installations which seemed similar, since allowances were made mostly by empirical means. A formula was developed by R. F. Vogt, chief consulting engineer of Allis-Chalmers Manufacturing Company, which includes not only the tension and centrifugal forces of early formulas but also accounts for the bending stresses as the V-belt passes around the small sheave. The ratings given here are based on this new conception.

High starting torques of some types of electric motors, vibration, and other peculiarities of installation have made it necessary to introduce service factors for best life. These are given in the tables, and the method of applying them is shown in the example.

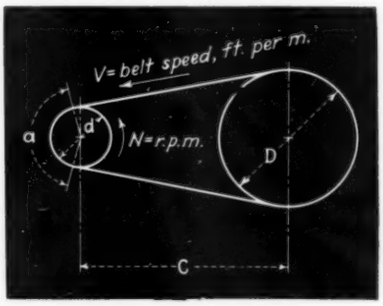


Table 1—CORRECTION FACTORS—BELT-CONTACT ARCS

Arc of Contact	*Correction Factor*	*Arc of Contact*	*Correction Factor*
180 deg.	1.00	130 deg.	0.86
170 deg.	0.98	120 deg.	0.83
160 deg.	0.95	110 deg.	0.79
150 deg.	0.92	100 deg.	0.74
140 deg.	0.89	90 deg.	0.69

Table 2—HORSEPOWER RATING OF V-BELTS

Belt Section	Pitch diam., in.	Belt speed, ft. per min. 1500	2500	3500	4500
		Hp. of single belt			
	2.6	0.8	1.1	.....	.....
	3.0	1.0	1.5	.....	.....
	3.4	1.1	1.7	.....	.....
A	3.8	1.3	2.0	2.5	.....
	4.2	1.4	2.1	2.7	.....
	4.6	1.4	2.3	2.8	3.2
	5.0 & up	1.5	2.4	3.0	3.4
	5.0	1.8	2.8	3.4	3.5
	5.4	2.0	3.1	3.8	4.0
B	5.8	2.1	3.3	4.1	4.4
	6.2	2.3	3.5	4.4	4.8
	6.6	2.4	3.7	4.7	5.1
	7.0 & up	2.5	3.9	4.9	5.4
	7.0	2.9	4.5	.....	.....
	8.0	3.6	5.7	7.1	.....
C	9.0	4.2	6.6	8.4	.....
	10.0	4.6	7.3	9.4	10.7
	11.0	5.0	8.0	10.3	11.8
	12.0 & up	5.3	8.5	11.0	12.7
	12.0	6.5	10.1	12.4	.....
	13.0	7.5	11.6	14.6	.....
D	14.0	8.2	12.9	16.5	.....
	15.0	9.0	14.1	18.1	20.3
	16.00	9.6	15.1	19.5	22.1
	17.0 & up	10.1	16.0	20.7	23.5
	20.0	11.7	18.3	23.0	.....
	21.0	12.5	19.6	24.9	.....
	22.0	13.2	20.8	26.6	.....
	23.0	13.9	21.9	28.1	31.7
E	24.0	14.5	23.0	29.5	33.5
	25.0	15.1	23.9	30.8	35.2
	26.0	15.6	24.7	32.0	36.7
	27.0	16.1	25.5	33.1	38.2
	28.0 & up	16.5	26.3	34.2	39.5

Formulas to Use

Let V = belt velocity, ft. per min., L = belt length, in.; C = distance between pulley centers, in.; D = diameter of driven sheave, in.; d = diameter of sheave on motor shaft, in.; N = motor-sheave speed, r.p.m.; Hp_b = required horsepower rating of belt; Hp_m = motor horsepower; F_s = service factor; F_c correction factor for arc of belt contact; and a = arc of belt contact. Then

$$V = 3.14(d/12)N$$

$$L = 2C + 1.57(D+d) + [(D-d)^2/4C]$$

$$a = 180 - [60(D-d)/C]$$

$$C = (b + \sqrt{b^2 - 32e})/16$$

$$Hp_b = (Hp_m \ F_s)/F_c$$

wherein $b = 4L - 6.28(D+d)$, and $e = (D-d)^2$. The correction factors can be interpolated from the tables.

The following example shows how these formulas are applied: Find the number and length of C-section belts for driving a centrifugal fan at 415 r.p.m. with a 25-hp., 1160-r.p.m., a.c. motor. The sheave on the motor shaft is 11 in. diameter, while the sheave on the fan is 30.8 in. diameter. The distance between sheave centers is 50 in.

Substituting in the formulas, V = 3,340 ft. per min., L = 167.586 in. (use nearest length furnished by suppliers); and the arc of belt contact = 156.24 deg. From Table 3, page 635 the service factor F_s = 1.4. The correction factor for the arc of belt contact, interpolated from Table 1, is 0.94. The total required horsepower rating of the belts is (25x1.4)/0.94 = 37.4 hp. By interpolation from Table 2, it is found that a C-section belt running at 3,340 ft. per min. over an 11 in. sheave is good for approximately 10 hp.; therefore, the number of belts required is 37.4/10 = 3.74—use four belts.

Companies cooperating in establishing the ratings and service factors include:

Allis-Chalmers Manufacturing Company
American Pulley Company
Browning Manufacturing Company
Dayton Rubber Company
R. & J. Dick Company
Dodge Manufacturing Company
Fort Worth Steel & Machinery Company
Gates Rubber Company
L. H. Gilmer Company
Golden's Foundry & Machine Company
B. F. Goodrich Company
Goodyear Tire & Rubber Company
W. A. Jones Foundry & Machine Company
Worthington Pump & Machine Corporation
Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc.
Medart Company
Pyott Foundry & Machine Company
Rockwood Manufacturing Company
U. S. Rubber Company
T. B. Wood's Sons Company

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New Departure, Division of General Motors, Bristol, Connecticut.

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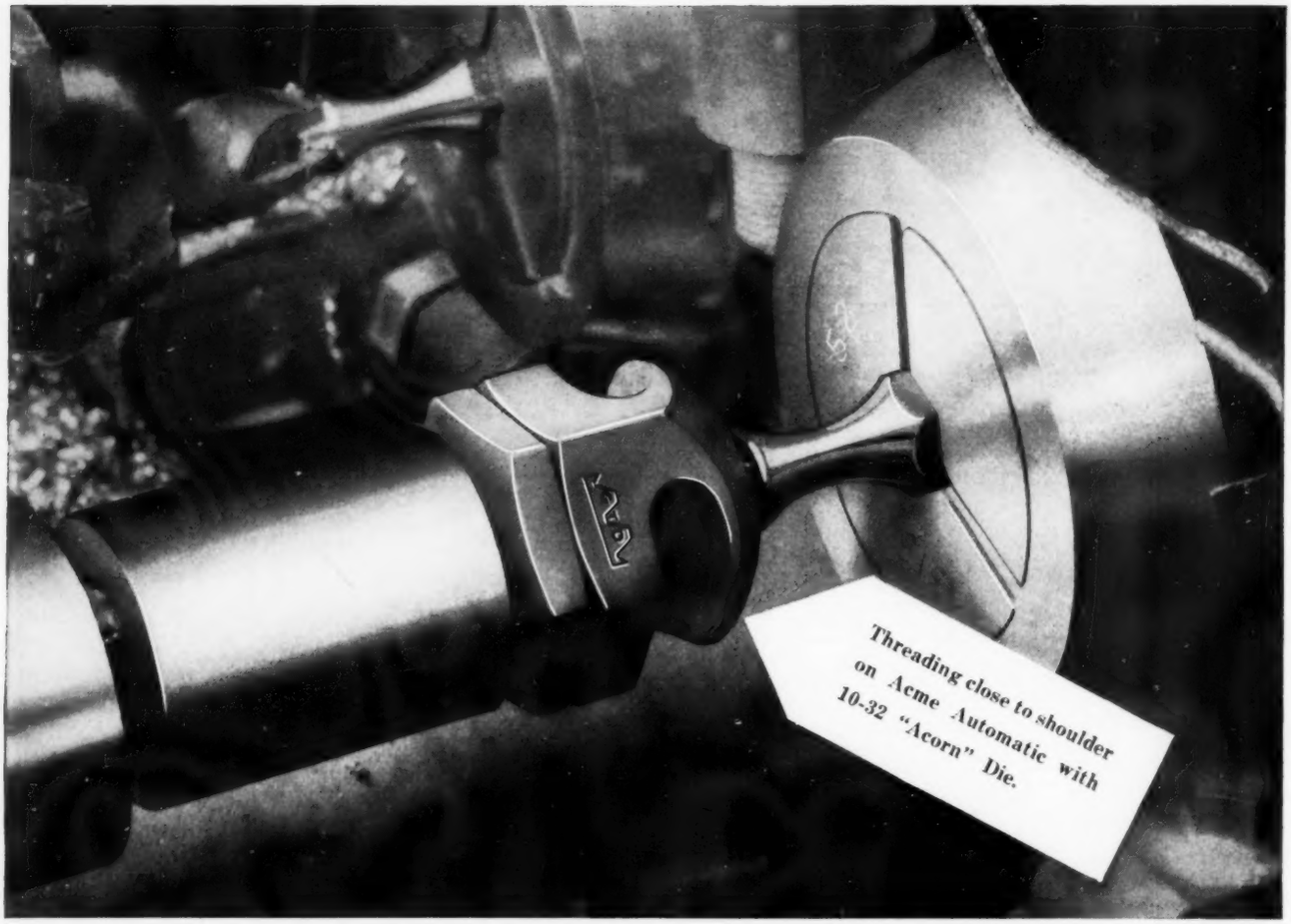
AMERICAN MACHINIST REFERENCE BOOK SHEET

Selection of V-Belts

Table 3—SERVICE FACTORS

APPLICATIONS	ELECTRIC MOTORS										ENGINES		
	a.c.								d.c.		Gas and diesel		
	Squirrel cage				Synchronous		Single phase						
	Normal torque, line start	Normal torque, compensator start	High torque	Wound rotor (slip-ring)	Normal torque	High torque	Repulsion and split-phase	Capacitor	Shunt wound	Compound wound	4 or more cyl. Above 700 r.p.m.	Steam	Line shafts and clutch starting
COMPRESSORS:													
Centrifugal	1.2	1.2	...	1.4	1.4	...	...	...	1.2	...	1.2	...	...
Rotary	1.2	1.2	...	1.4	1.4	...	1.2	1.2	1.2	...	1.2	...	...
Reciprocating —													
3 or more cyl	1.2	1.2	...	1.4	1.4	...	...	...	1.2	...	...	...	...
1 or 2 cyl	1.4	1.4	...	1.5	1.5	...	...	...	1.2	...	...	...	...
CONVEYORS:													
Apron	...	1.4	1.6	...	...	...	...	...	1.4	...	...	...	1.6
Belt (ore, coal, sand)	...	1.2	1.4	...	...	...	...	...	1.2	...	...	...	1.4
Belt (light package)	...	1.0	1.1	...	...	...	...	...	1.0	...	...	...	1.2
Oven	...	1.0	1.1	...	...	...	...	...	1.0	...	...	...	1.2
Screw	...	1.6	1.8	...	...	...	...	...	1.6	...	...	...	1.8
Bucket	...	1.4	1.6	...	...	...	...	...	1.4	...	...	...	1.6
Pan	...	1.4	1.6	...	...	...	...	...	1.4	...	...	...	1.6
Flight	...	1.6	1.8	...	...	...	...	...	1.6	...	...	...	1.8
Elevator	...	1.4	1.6	...	...	...	...	...	1.4	...	...	...	1.6
FANS AND BLOWERS:													
Centrifugal	1.2	1.2		1.4	...	...	...	...	1.2	...	1.2	...	...
Propeller	1.4	1.4	2.0	1.6	...	2.0	...	...	1.4	...	1.4	...	...
Induced draft	1.2	1.2	...	1.4	...	...	...	...	1.4	...	1.4	...	...
Positive blowers	1.6	1.6	...	2.0	2.0	2.0	...	...	...	...	1.6	...	...
Exhausters	1.2	1.2	...	1.4	...	...	...	...	1.4	...	...	1.5	1.5
GENERATOR AND EXCITERS	1.2	...	...	...	...	...	...	...	1.2	...	2.0	1.4	1.4
LINE SHAFTS	1.4	1.4	...	1.4	1.4	2.0	1.4	1.4	1.4	1.4	1.6	1.6	1.6
MACHINE TOOLS:													
Grinders	1.2	...	...	1.4	...	...	1.2	1.0	1.2	1.2	...	...	...
Boring mills	1.2	...	...	1.4	...	...	...	...	1.2	1.2	...	...	...
Lathes	1.0	...	...	1.2	...	...	1.0	1.0	1.0	1.0	...	...	...
Milling machines	1.2	...	...	1.4	...	...	...	...	1.2	1.2	...	...	...
Screw machines	1.0	...	...	1.0	...	...	1.0	1.0	1.0	1.0	...	...	...
Cam cutters	1.0	...	...	1.0	...	...	...	...	1.0	1.0	...	...	...
Planers	1.2	...	...	1.4	...	...	1.2	1.0	1.2	1.2	...	...	...
Shapers	1.0	...	...	1.0	...	...	1.0	1.0	1.0	1.0	...	...	...
Drill presses	1.0	...	...	1.0	...	...	1.0	1.0	1.0	1.0	...	...	...
Drop hammers	1.0	...	...	1.0	...	...	1.0	1.0	1.0	1.0	...	...	...
Shears	1.2	...	...	1.4	...	...	1.2	1.2	1.2	1.0	...	...	...
MILLS:													
Pebble	...	1.4	1.6	1.4	...	...	...	...	...	1.4	...	...	1.6
Rod	...	1.4	1.6	1.4	...	...	...	...	...	1.4	...	...	1.6
Ball	...	1.4	1.6	1.4	...	...	...	...	...	1.4	..	...	1.6
Roller mills	...	1.4	1.6	1.4	...	...	...	...	...	1.4	...	...	1.6
Flaking mills	...	1.6	1.6	1.4	...	...	...	...	...	1.4	...	...	1.6
Tumbling barrels	...	1.6	1.6	1.4	...	...	...	...	...	1.4	...	...	1.6
PUMPS:													
Centrifugal	1.2	1.2	1.4	1.4	...	...	1.2	1.2	...	...	...	...	...
Gear	1.2	1.2	1.4	1.4	...	...	1.2	1.2	...	...	...	...	...
Rotary	1.2	1.2	1.4	1.4	...	...	1.2	1.2	1.2	...	1.2	...	...
Reciprocating—3 or more cyl	1.2	1.2	...	1.4	1.4	1.6	...	...	...	...	1.8	1.8	...
1 or 2 cyl	1.4	1.4	...	1.6	1.6	1.8	...	...	...	...	2.0	2.0	...
Dredge pumps	1.4	1.4	...	1.4	...	...	...	...	...	...	2.0	2.0	...



MORE PRODUCTION with "ACORN" DIES

Every year more manufacturers turn to genuine "Acorn" Dies because of the way they handle jobs like this one. This 10-32 High Speed Steel "Acorn" Die on a multiple spindle automatic is threading safety razor handles. Sustained accuracy and ability to cut close to a shoulder are essential requirements. "Acorn" Dies fill the bill, to the tune of over 15,000 threaded parts per die! G. T. D. Greenfield was the originator of the "Acorn" Die—the die with positive concentric adjustment. G. T. D. Greenfield engineers know how and where "Acorn" Dies can be most advantageously used. This picture shows how compact the "Acorn" Die is—shows how close to a shoulder it will cut. Remember, too, they operate equally well on fixed or live spindles. Ask your supply house or G. T. D. Greenfield for full data.

GREENFIELD TAP & DIE CORPORATION, Greenfield, Mass.

Detroit Plant: 2102 West Fort St. Warehouses in New York, Chicago, Los Angeles and San Francisco. In Canada: Greenfield Tap & Die Corp. of Canada, Ltd., Galt, Ont.

GTD GREENFIELD

TAPS · DIES · GAGES · TWIST DRILLS · REAMERS · SCREW PLATES · PIPE TOOLS

No Substitute for Time

MUCKRAKING of the defense program has begun. It is directed against industry as the big bad wolf, with the government in the role of Little Red Riding Hood.

Screaming at prospective readers from the newsstands a week ago was an eight-column scare head "Strike of Capital Delays National Defense" on the first page of *The New York Post*. The next day appeared another streamer head "Plane Firms Spurn Contracts to Lobby for Higher Profits." The articles were part of a series to expose the reasons for delays in the defense program.

Concludes an editorial comment in the same paper, "The war industries have had a three-month trial under a wholly voluntary system. Some of the most vitally needed groups have failed to meet the test. Now is the time for the selective draft of industry."

If we choose to chalk up this attack on industry to ignorance rather than to malice, it demonstrates one vital point. The fact must be driven home to the public that you can't press a button and have tanks instead of automobiles roll off a line.

As yet the United States does not have war industries. The government and manufacturers are feverishly trying to create such industries. That effort consists of establishing new plants to make war materiel heretofore made only in government arsenals or not at all, and converting existing plant facilities from production of peacetime goods to fabrication of wartime goods.

No matter how you look at it, that is a gigantic task. It takes time. And for time there is no substitute. When we recently asked a high-ranking military officer how long it would take to get going, he answered unhesitatingly, "Two years." It may be possible to shorten that time period, but not much.

It is more likely to be lengthened if the administration should repeat its performance in connection with amortization of new defense plants. Who can blame industry for reluctance to invest its capital in new factories designed solely to meet defense needs, if it must continue to pay taxes on them perhaps long after their useful function has ceased?

Industry might well ask, "How long will the defense fever last?" Nobody is able to answer. After the World War it ceased abruptly. It can do the same thing again. What guarantee does industry have that it will not be left "holding the bag?" Even *The New York Post* concedes that industry should be protected against loss.

Yet when industry tried to secure legislation authorizing the quick writing off of plant investments for defense, Secretary Morgenthau bitterly opposed it for weeks. Over the pleas of his defense chiefs the President insisted on tying together amortization and excess profits in the same bill. Altogether a sixty days' delay has occurred.

There have been other delays in which industry has had no part. First the military authorities want one tank design, then another. In some cases the desire to put into a war product all the experience learned to date from the European war has outrun the practical consideration that a thousand units slightly outmoded are worth a thousand times more than one up-to-date unit which has never left the drawing board.

Many industrialists are disturbed because of the slowness with which orders have come out of Washington. They realize that the uninformed public soon will be asking, "Where are all the airplanes and tanks and guns that Congress has been spending our money for?

A big job remains to be done in educating people not to expect too much too soon. And it wouldn't hurt to start some of the education with the daily press, which is relatively unfamiliar with industrial processes. *The New York Post* is a case in point.

Burnham Finney

GAGING BUSINESS

Canadian munitions makers buy machine tools. Plane builders and Chrysler are important purchasers. 900 planes to be produced in August. British to place big orders in this country

Problems of plant expansion and of retooling for production of munitions and related items for national defense continue to absorb the attention of the metal-working industry. Operations and payrolls are at a high level and will rise further in the fall. The most active winter since world war days lies ahead for manufacturers. Potential shortages of skilled help are among the chief worries.

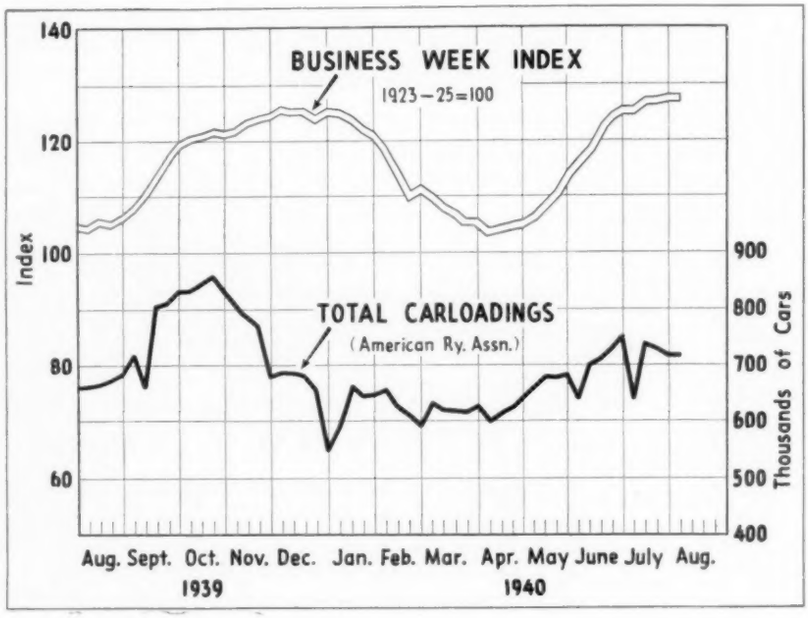
Machine Tools—Large quantities of machine tools have been purchased the past two weeks, but not so much has come from Britain. Canadian munitions makers bought heavily. U. S. aviation companies, particularly engine builders, have placed large orders. Government arsenals and navy yards too have been important buyers. Chrysler, getting ready to fabricate tanks on a mass scale, already has contracted for sizable numbers of machine tools. A variety of industries, including automobiles, refrigerators and tractors, have been in the market for new equipment. The volume of inquiries likely to appear in the next 60 days is almost unprecedented. One government plant alone will need $30,000,000 of machine tools, and that is only one of many. Production recently dropped slightly because many machine tool plants shut down for annual vacations, but it has been maintained straight through the summer at more than 100 per cent of what the industry's capacity was last September. Since that time plant facilities have been enlarged almost 30 per cent. Fewer delays are now encountered in securing export licenses promptly than when expert control was first established in July.

Railroad Equipment—Around 4,700 freight cars have been bought since August 1. Atlantic Coast Line has ordered 615 cars from Pullman, 800 from Bethlehem and 150 from Mount Vernon Car. Southern Pacific has contracted for 500 cars each from General American Transportation, Pressed Steel Car, Bethlehem and Mount Vernon Car, and 350 from American Car & Foundry. Louisville & Nashville will take 100 cars from Pullman. Orders have been placed recently for 30 steam and 18 diesel electric locomotives. The Rock Island is asking bids on trust certificates for 1,100 freight cars which it wishes to buy.

Steel—Barring an early peace, steel production in the fourth quarter is likely to run 90 per cent or higher. Output is at that level now. Export demand, particularly to Great Britain, accounts for more than 15 per cent of current sales. Recently considerable steel is believed to have been bought for inventory. Electric furnaces are now being installed to take care of any possible shortage in alloy melting capacity.

Aircraft—About 900 planes, half of which will be trainers, will be turned out in the United States this month. By the year-end the monthly total will be 1,500. The British have been informed that production of combat planes, exclusive of trainers, will rise to 1,300 a month by late 1941. Expansion of Douglas' plants in California, at cost of $20,000,000, is the forerunner of other gigantic increases in the industry's plant capacity. Wright will farm out a large amount of parts work at its projected Cincinnati engine factory. Pratt & Whitney is reported contemplating further plant additions at East Hartford. Allison is now purchasing new equipment supposedly for expansion of its engine-building capacity. North American Aviation has received an order from the War Department for 700 training planes costing $11,335,631.

Munitions—Projects are slowly getting out of the "talk" stage. Within the next week 15 to 20 out of the Army's 67 munitions plants to be financed by the government will be awarded, all of them to be located inland. Chrysler will make about 1,000 tanks of 25-ton rating under a $54,500,000 award for plant and equipment made by the War Department. The government will own the plant which will be built by Chrysler. $20,000,000 will go for plant equipment. The British are negotiating for 4,000 tanks in this country. If the war continues through the winter, it is believed the British will place war orders here which will rival or exceed in size the U. S. Government's program. British purchases from now on will be standardized to conform to regular equipment of the U. S. Army and Navy. A naval gun factory as large as the one now in Washington is being planned. General Electric has an order for $4,671,000 of anti-aircraft equipment.



WILL BUILD 30 GOVERNMENT ORDNANCE PLANTS

$300,000,000 will be set aside for this defense project in the pending five billion dollar military appropriation. The plants will be privately operated and built to specifications

By ROBERT COLBORN

WASHINGTON—Thirty government-owned ordnance plants will be built with money—about $300,000,000—to be provided in the pending five billion dollar military appropriation. They will be operated under contract by private firms and built to the specifications of the operating firm; this is the same procedure followed on the Indiana powder plant du Pont has contracted for. Locations of most have not yet been determined and in any case are a deep secret. It is known however that they will be placed west of the mountains, mostly east of the Mississippi, and at least 200 miles north of the Mexican border; an effort will be made to stay 200 miles south of Canada, but this will not be possible in all cases.

The area within these boundaries is split up into five "ordnance areas" among which the plants will be distributed. Intention is that plants will be so located that, together with existing munitions plants, they will provide a complete munitions-production set-up in each district; if one district is captured or bombed, it will not interfere with production in the others. Area A includes northern Indiana and Illinois, southern Wisconsin and Minnesota, and all of Iowa. Area B includes Ohio, the southwestern part of Pennsylvania, West Virginia and Western Virginia, and eastern Kentucky. Area C includes southern Indiana and Illinois, western Kentucky, Missouri, and eastern Kansas. Area D includes western North Carolina, northern Georgia and Alabama, and eastern Tennessee. Area E includes western Tennessee, Arkansas, Oklahoma, and the northern part of Mississippi, Louisiana and Texas.

$20,000,000 Powder Plants

Biggest of the new factories will be two $20,000,000 smokeless powder plants and a $20,000,000 ammonium-nitrate plant for extraction of atmospheric nitrogen. Supplying the latter, will be a $15,000,000 ammonium plant. Seven shell-loading plants will average $10,000,000 apiece, as will a small arms ammunition plant. Eight plants for manufacture of various explosives will cost a total of $53,500,000. A cotton purification plant will cost $6,000,000, and three plants for fuse and bag loading will total $15,500,000. Seven metal-working plants are contemplated: four $6,000,000 shell-forging plants, two $7,000,000 aircraft cannon factories, and a $12,000,000 machine gun factory.

A further $465,000,000 will be needed later, but it is not believed that it can be put under way this year, so no appropriation has been asked.

Slow Progress Is Being Made

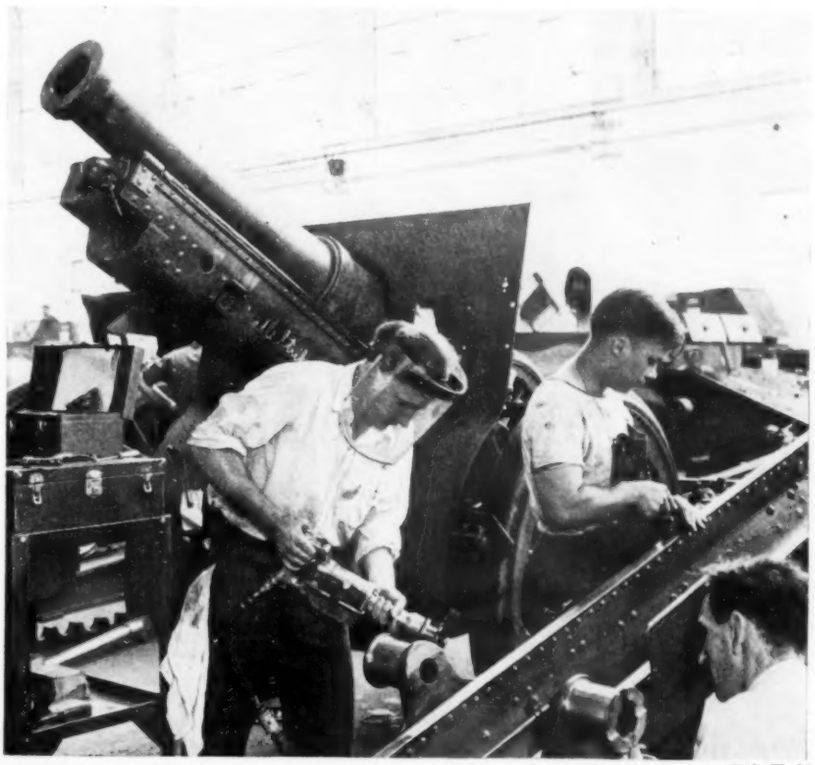
Fairly slow progress is being made in utilization of the $200,000,000 already appropriated under the same head of "expediting production." About $13,000,000 has been allocated to improvement of existing arsenals. It has been decided to use $520,000 for an anti-aircraft searchlight plant, but no contract has been approved. Negotiations are underway with the Hercules Co. for a $15,000,000 smokeless powder plant. In addition $95,000,000 has been tentatively allocated to aircraft plants and turned over to the defense commission, but it is not planned to build any aircraft plants during the immediate future.

The shell-forging plants, to be provided with the new money, will be simple factories for forging and machining shells. They will be expected to turn out enough shells to supply an army of 2,000,000 men. They will be located in the steel areas, Birmingham, Pittsburgh, and Chicago.

Plants Will Make Airplane Cannon

The cannon plants will manufacture 20-mm. and 37-mm. cannon for installation on airplanes—one of the new developments that has come out of the war. Probably General Motors will operate one of the plants and Chrysler the other; they will be located in the Middle West. In addition Bendix is building a few cannon, and it will probably be necessary to install some government machinery. Chrysler expects to build a few cannon in its existing plants, despite the fact that it will undertake a huge order for tanks.

Plans for the $12,000,000 machine gun plant are now being worked out with a manufacturer. It is intended to use some of his existing buildings, so most of the money will go for tools and fixtures, so as to strive for optimum output with the lowest average cost.



Wide World

Almost Ready—*U. S. tank and gun production is being rushed in plants and arsenals throughout the country. At the Rock Island Arsenal the carriage of a 155mm Howitzer is receiving the finishing touches with a motor driven buffer. At right men scrape to secure a smooth finish*

May Tax "Excess Profits" 25 to 40 Percent If Present Amortization Bill is Passed

WASHINGTON—The tax-amortization legislation has a long way to go before it reaches the President's desk, and some changes in the original draft are already being discussed, but chances are that the broad outlines will be retained. Briefly the bill would permit amortization of plant, for tax purposes, over a five-year period, and would tax "excess profits" at a rate ranging from 25 to 40%.

The rapid amortization would apply both in computing the excess profits tax and ordinary income tax. The period of amortization may be shorter: If the emergency is terminated by the President in less than five years the amortization may be re-figured retroactively over the shorter term. Similarly, if the Secretary of War or Navy certifies that a particular facility is no longer useful for munitions production, it may be amortized over the period during which it was useful. These procedures now apply to "lands, buildings, machinery or equipment" installed after July 10 of this year. The administration is supporting a change to make the date Jan. 1, 1940.

To be eligible for rapid amortization, facilities must be certified by the Defense Commission as well as by the Army or Navy.

There is a possibility that some strings may be put on rapidly-amortized facilities. Army and Navy are believed to favor a plan by which facilities would have to be maintained in shape to produce munitions, on a standby basis, after being written off. This is opposed by the Defense Commission.

The subcommittee preparing the bill recommended that if defense orders cease before the manufacturing facilities are paid for, the government reimburse the manufacturer for the difference and that such payments be exempt from taxation.

The bill repeals the Vinson-Tramel limit on profits of ship and plane manufacturers and substitutes an excess-profits tax applying to all corporations (except personal service corporations), defense or otherwise. The first $5,000 of excess profit is tax-free. Thereafter a tax must be paid varying from 25 to 40% depending on the ratio which excess profits bear to normal profits.

Amount of excess-profit may be computed, at the taxpayers choice, in two ways. It may be obtained by subtracting from net income in the taxable year the average income during a base period 1936-39, with a technical adjustment for changes in capitalization.

Alternatively, the taxpayer may deduct from his net income an amount equal to what his income would be if he had earned, on his present invested capital, the same rate as he earned on his capital during the base period. This rate could not be more than 10% or less than 4% (6% on the first $500,000 of capital). Invested capital is defined as equity capital plus a percentage of borrowed capital (roughly, all of the first $100,000, two-thirds of the first $1,000,000, and a third of the rest.)

Corporations not in existence during part or all of the base period would use the capitalization method and assume, for the missing years, present capitalization and earnings of 10% on the first $500,000 of capital and 8% on the rest.

In general, corporations which earned less than 4% during the base period would use the invested capital computation. Those earning more than 10% would use the income computation. For the in-between cases the results would be about the same.

NO COMMANDEERING OF PLANTS

WASHINGTON—Industry won a skirmish in its battle with the Administration over amortization and other concessions on defense contracts when the House repealed the power granted the Secretary of the Navy to commandeer plants for munitions manufacture. This authority was the Administration's ace in the hole in event of an impasse over contract conditions; it had been planned to seek similar authority for the War Department. The repealer was tacked onto the $5,000,000,000 defense appropriation, on which the Senate has yet to act. The President can still force manufacturers to take orders under the Defense Act of 1916, but in doing so he makes the implicit announcement that war is "imminent."

Exports of Machinery During June, 1940

	June 1940	March 1940	June 1939
Electrical Machinery and Apparatus	$9,607,069	$10,335,418	$8,717,087
Power generating machinery except automotive and electrical	2,126,581	2,119,230	1,161,760
Construction and conveying machinery	3,115,301	3,223,837	2,558,330
Mining, well and pumping machinery	3,788,489	5,245,434	5,894,925
Power driven, metal-working machinery	18,564,300	18,267,473	6,660,447
Other metal-working machinery	596,917	922,889	403,905
Textile machinery	1,093,851	1,233,464	798,865

Metal-Working Machinery

Engine lathes	$1,530,297	$1,290,669	$379,883
Turret lathes	1,451,624	1,432,524	432,869
Other lathes	888,025	643,324	335,465
Vertical boring mills and chucking machines	809,499	797,520	177,625
Thread cutting and automatic screw machines	1,120,424	1,761,598	474,003
Knee and column type milling machines	367,955	740,759	399,730
Other milling machines	1,438,827	1,185,203	627,126
Gear cutting machines	798,420	735,039	268,595
Vertical drilling machines	261,353	229,164	121,621
Radial drilling machines	200,808	289,428	75,035
Other drilling machines	714,837	350,760	34,235
Planers and shapers	338,424	473,904	151,293
Surface grinding machines	298,060	550,668	193,667
External cylindrical grinding machines	437,110	379,553	214,493
Internal grinding machines	562,989	920,403	232,900
Tool grinding, cutter grinding, and universal grinding machines	306,839	856,532	323,551
Other metal-grinding machines and parts	748,398	845,701	291,525
Sheet and plate metal-working machines and parts	714,319	543,580	238,647
Forging machinery and parts	763,117	805,763	394,220
Rolling mill machinery and parts	2,884,832	1,414,317	387,114
Molding machines	23,690	45,377	15,276
Other foundry equipment and parts	176,041	110,336	46,835
Other power-driven metal-working machinery and parts	1,723,787	1,765,351	838,610
Pneumatic portable tools	73,285	466,856	111,469
Other portable and hand or foot-operated metal-working machines and parts	174,436	150,283	132,120
Chucks for machine tools	56,508	38,717	19,486
Milling cutters, machine-operated threading dies, and taps and similar machine operated metal cutting tools	106,649	88,336	72,355
Other metal-working machine tools and parts	186,039	158,697	68,475

U. S. Army Spends $43,859,180 For Specially Equipped Trucks

DETROIT—Army orders for trucks are being released in rising volume. A total of $43,859,180 has been awarded recently to many companies. Fargo Motor Corp. has received a $10,518,435 order for 13,556 half-ton trucks, 881 specially equipped sedans. All have a four-wheel drive and are being built to special Army requirements. These will be the first Army trucks designed for visibility during blackouts, and for operation over rough terrain day or night. Chevrolet has been awarded an $8,473,989 contract for 1½-ton trucks while Yellow Truck has received $15,254,786 for heavier trucks.

Plants May Lose 1 Out of Every 5 Young Men If Draft Bill Passes in Its Present Form

WASHINGTON—If the draft bill passes in its present form, about one in five of the unattached healthy youngsters in your plant will be called up for training within the next six months unless you can show that their jobs are "necessary to the maintenance of the national health, safety, or interest." When they finish a year's training you will have to give them their jobs back under penalty either of being up before the NLRB or of a suit in federal court—the point hasn't been decided yet. Employees must ask for the return of their jobs within 40 days after honorable discharge.

Everyone between 21 and 31—about 12,000,000 men—must register. It is estimated that about 4,000,000 names will remain after elimination of those with dependents, the physically unfit, and those with essential jobs. From this group, 400,000 will be called up during the quarter beginning Oct. 1 and another 400,000 starting in April. The following October about 600,000 will be called (to make up for dismissal of the National Guard).

Men called up will be permitted to defer rent, insurance premiums, taxes and installment payments falling due during the training period or war service.

No blanket exemptions for particular types of worker will be granted. Decision will be made on each individual case, based on a questionnaire and personal interview. The job of deciding is done by local draft boards appointed by the governors. For their guidance, the boards will have a list of industries and skills where defense shortages are expected and will check with local firms as to government contracts held.

Similar rules apply to the National Guard and reserves. All the guardsmen and about half the 100,000 reserve officers will be called up. However, guardsmen with dependents are now being released, and industrial exemptions will be made when the time comes.

Senate Committee Holds Hearings On Amendments to Wagner Act

WASHINGTON—Senate Labor Committee is holding hearings again on the amendments to the Wagner Act, which were passed by the House. Politicos here say this is a stall: the hearings are put on only because the session was strung out by the defense program, and there was no further excuse for the pigeon hole. Labor is screaming that defense equipment makers are threatening its gains under the New Deal. Industry hollers back that labor is putting on the squeeze in an emergency. Both sides are turning the heat on the Senate. Although the experts don't expect any action this session on the Wagner amendments, this is the last session of the 76th Congress. If the Senate doesn't act, the bill passed by the House will automatically wash off the slate, which must be clean for the 77th Congress. Some observers indicate that amicable relations between labor and business may not come until too late.

Index of Articles on Defense Published by American Machinist

An index of articles on National Defense problems and munitions production which have appeared in American Machinist in the past year and a half has just been completed. Mimeographed copies of the index are available to readers on request. They are free of charge.

Split Bids and F.O.B. Factory Acceptable to Defense Commission

WASHINGTON—In order to hasten the delivery of equipment and at the same time to spread contracts over the country, the National Defense Commission has adopted two new policies: acceptance of bids F.O.B. factory (instead of army depot), which nullifies any disadvantage a bidder might have through the geographical remoteness of his factory; and acceptance of split bids for portions of large orders, which enables many small manufacturers to participate in orders which would otherwise go to large manufacturers.

Some observers indicate this to be a victory for mid-west senators who called on the Defense Commission for greater consideration to manufacturers in the region between the Rockies and the Appalachians.

In cases where the government is furnishing the material bidders will be informed that, under the new policies, such material will be delivered to the plant without any expense to the contractor. In split bids the invitations will advise the bidders of the maximum and minimum quantities which may be awarded.

Welding The U.S. Defense—*At Rock Island Arsenal, Ill. welders are being initiated into the intricacies of producing artillery material by modern methods. Stringent instruction is given to the students as the above picture, released by the Ordnance Department, U.S. Army, indicates*

Despite Lack of Labor Disputes, Trouble May be Ahead as Defense Plans Are Rushed

As the defense program creeps toward full tide, expanded plant and increased production have effected a substantial reemployment, subtly transforming an important part of the labor market from a buyer's market to a seller's. First fruits of the change has been the growing restiveness of organized labor which finds its bargaining position enhanced. In other times, comparable movements of the industrial index have been the signal for an epidemic of strikes as unions moved to secure for these members a measure of the prosperity which better business promised for their employers. One of the most interesting phenomena of the current boom period has been the comparative dearth of labor disputes which have led to work stoppages.

Two things, one psychological and one logical, may explain it. The psychological influence is accountable to the temper of the times. A labor leader does a lot of thinking these days before he calls a strike. With a defense-minded country convinced that increased production is the number one item on our agenda for preparedness, he will hesitate a long time before risking the loss of one of the most decisive elements in any labor dispute: public sympathy. Unless a union chief can make out a waterproof case for striking, he knows that such action will have public opinion solidly against him.

Hillman's Work Cited

The other factor which explains the peaceful summer on the labor front is the work of the Labor Division of the National Defense Advisory Commission. Under the direction of Sidney Hillman, the Labor Division has moved immediately into every potential trouble zone where a dispute threatened to embarrass defense production. Urging conciliation, mediation, or arbitration; pleading for time, for reasonableness, for compromise; appealing to patriotism and unselfishness, Hillman and his aides have done an unprecedented job of strike prevention.

Some of the fevered spots which responded to the Hillman treatment and are now doing nicely are, (1) General Motors, where a deadlock in contract negotiations threatened a serious strike—Hillman's intervention affected a compromise, got a contract agreed on, and led to the establishment of a grievance handling plan which now functions about as smoothly as any in the country. (2) Federal Shipbuilding, where an unauthorized, wildcat strike was about to put a brake on naval building—Hillman got the men back to work on an arrangement in which the company promised to grant immediate pay boosts, consider further advances; Federal now operates at capacity. (3) Aluminum Company of America, where, citing the company's profits for 1939, the C.I.O. demanded a 10c an hour wage increase, and the company refused to raise rates, contending that it would put Alcoa wages out of line with wages which prevailed in the communities where Alcoa had plants—Hillman stepped in, and with arguments which occasionally lasted eighteen hours at a stretch, prevailed on the union and the company to agree on a 2c an hour increase in pay.

Trouble Still Ahead

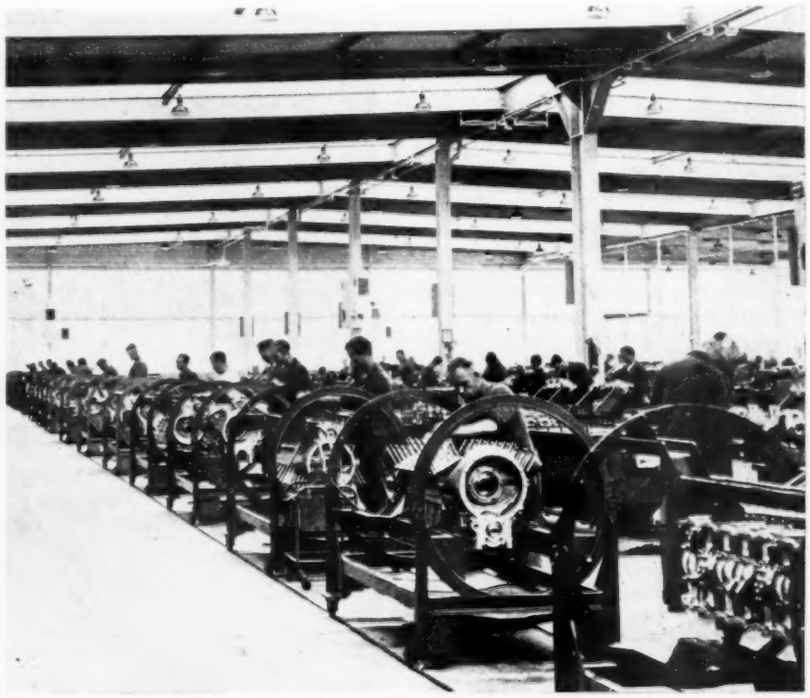
But pluperfect as the record is, the Defense Council peacemakers are not out of the woods. Coming up are new hotspots which will challenge the ingenuity and the tenacity of the Hillman technique. Trouble for the aircraft industry is in sight as the C.I.O. auto workers announce a whirlwind campaign to organize that largely unorganized industry. It is open gossip in Washington that the Administration would like to see aircraft organized. The suggestion is that a system of institutionalized collective bargaining in the industry will keep both labor and management responsible and provide the machinery necessary to keep grievances from inhibiting production.

Another industry likely to have trouble is shipbuilding. Bethlehem, Todd, and others are either currently involved in labor trouble or sit uneasily on hot seats. Before the snow flies, Hillman may have his hands full of shipyard problems.

The only fly in Hillman's salve is John L. Lewis, who as C.I.O. head is technically Hillman's superior in the labor movement. Lewis has already charged Hillman with favoring the rival A.F.L. and hints darkly that the Defense Commissioner is playing the employer-Roosevelt game.

NEW EXPORT REGULATIONS EXPECTED

WASHINGTON — Supplemental rules and regulations for the export of machine tools are expected to be issued this week by the office of the Administrator of Export Control. They will include a revision of the questions which machine tool builders must answer when they make applications for export licenses. It is planned to ask more specific questions about the machines to be exported. The Administrator of Export Control states that delays have occurred in granting licenses because information supplied has in many cases been inadequate.



Germany's Power—*Tens of thousands of Junkers Jumo 211 aircraft engines have been produced to power Germany's "Stukka" dive-bombers and other war planes. In one of the Junkers factories (above) these 1,200 horse-power inverted V-type gasoline engines are finally assembled en masse*

WATCHING WASHINGTON

Shortage of skilled labor causes no delay in defense program. No penalty clauses in defense contracts; government will try to simplify specifications; Army stands pat on Garand rifle.

BY BLAINE STUBBLEFIELD

WASHINGTON—Despite all the talk about shortage of skills in defense production, no instance of delay for that cause has yet come to light. This conclusion is confirmed by Dr. Isador Lubin, Commissioner of Labor Statistics, who is now serving on the Hillman labor supply staff of the Defense Commission and by Sidney Hillman.

Measures being taken by the Government and by employers to provide against skill shortage are almost entirely in anticipation of future short supply. It is true of course that the arsenals, the Navy yards, and private employers manufacturing defense equipment are not getting the kind of men they want. But the *ideal* man is never hired by anybody.

It is true also that long lines of men are waiting outside personnel windows and few of them are hired. But the reason is that few of them have the training wanted. The Glenn Martin Company is a case in point. Martin is getting enough men, but the company must interview a tremendous number.

The government's most recent step to provide skills for the anticipated shortage in defense production is the Defense Industries Employment Register, set up by WPA. The Register is examining the work records of 2,500,000 persons on or awaiting assignment to WPA rolls. This analysis will show the workers' skills, or aptitudes in which they can be given training under the vast Hillman training program of the Office of Education and the Defense Commission. In addition to voluntary statements of the 2,500,000 workers, WPA has performance records of about 1,700,000 workers employed.

Further steps to increase defense production by adding men and increasing shifts have been taken by both Army and Navy, in cooperation with the Hillman office. The War Department ordered all six arsenals on a three shift basis August 10. Laborers and mechanics are paid time-and-a-half for over 40 hours per week.

Meanwhile the Navy, on August 8, authorized all stations and yards to work employees in excess of 40 hours with overtime pay as permitted by law. But, meanwhile, Secretary Knox directed that the working force be increased to permit expansion of shifts and reduction of overtime. He asked that no employee be worked more than 48 hours a week unless necessary. The Secretary, contending that in certain localities skill shortages exist in special occupations, urged all naval contractors to foresee labor requirements and to inform State and Federal employment agencies of their needs, so as to avoid delay and to minimize migration. He urged also that "pirating" be diminished. He said that present shortages are due to failure of industry to maintain apprentice programs during the lean years after 1929.

No Penalty Clauses

Penalty clauses are not going to be included in defense manufacturing contracts. The priorities division set up in the Army and Navy Munitions Board wants to be free to juggle delivery dates when it seems desirable without having to argue over financial penalties. Outstanding government contracts with a penalty on the delivery date will be modified when they have to be pushed aside in favor of a "preference contract." This matter is being handled by the defense commission, and manufacturers who get into a tangle should go there for help.

MAY SIMPLIFY SPECIFICATIONS

The defense emergency may reduce the multitude of government specifications that have grown up in different agencies for the same thing. James Lynah, on the staff of Procurement Coordinator Donald Nelson, has been assigned the job of coordinating standardization studies now being made by different agencies. So far, he is still finding out what effect on production the variations in specifications have. Later, the worst cases will be straightened out. There is slight prospect of any general revision of federal specifications, but some simplification may result. Also being considered is an agreement by which all procurement agencies would accept A.S.T.M. standards as alternatives to their own.

Score on the Garand

Army, officially, is still standing pat on its own design for a semi-automatic rifle, the Garand. But opinion is still divided even within the department. The Marine Corps, in particular, are not at all sold on it. Although they are allotted 13,000 Garands under the pending $5,000,000,000 bill, they still think maybe they'd rather have 1903 Springfields, on which production has been stopped. Moreover, the marines are interested in an experimental semi-automatic that Winchester has worked up. The Corps thinks the Winchester will cost about half as much as the Garand and can be turned out faster. Secret tests of the Winchester were made this month, but Ordnance is keeping completely quiet about the results. Meanwhile, Army denies the reputed faults of the Garand—overheating and muzzle droop—and points out that even if some other rifle might be better, the Garand is in production and it would take time and create confusion to switch over.

Plan Great Lakes Sub Making

Navy is busy discussing with every shipyard in the country, including those now out of commission, the part they can play in the pending fleet expansion. Actual contracts are waiting until Congress completes action on the $5,000,000,000 appropriation, but preliminary problems are being thrashed out. Nearly the only yards in commission that are not now chock-a-block are those in the Great Lakes, and these will probably be drawn extensively into naval work for the first time since the war. Typical of the problems involved is how to get submarines, in which some yards are interested, to the ocean. The St. Lawrence locks are too small, but a plan is being worked out by which the subs would go down the Illinois River, partially submerged to get under bridges, as far as Lockport. There they would be put on a floating drydock with shallow enough draft to negotiate the Illinois and upper Mississippi, and down the lower river under their own power.

No Turtle-Back Battleships—Yet

Turtle-back battleship plans proposed a few months ago as an answer to aerial bombardment have boiled down to a program of substituting guns capable of both surface and anti-aircraft fire for some now only usable against surface craft, and increasing the protective screening around some of the deck guns.

Foreign Owners of Machine Tools in U. S. Ports Will be Paid Off by the Government

WASHINGTON — The problem of how to recover title to machine tools suitable for defense needs but held legally at U. S. ports by foreign governments, such as Japan, is about to be solved. A bill, certain of passage, has been introduced in Congress giving the President power to requisition such tools the exportation of which has been denied.

The bill provides that the government shall pay the owner a sum which "the President shall determine to be fair and just." If the owner is unwilling to accept the sum fixed, he shall be paid 50 per cent of it and shall have the privilege of suing the Federal government for whatever amount he thinks is still due. Authority to run until June 30, 1942.

It is reported that necessity for legislation arose as a result of the reluctance of Japan to surrender to the U. S. Army and Navy many machine tools in her possession in this country for which export licenses could not be procured. These machine tools had been completed by the builders and paid for, so that they were the property of the Japanese government. Many of them are at shipside and are of the type needed at present on defense projects.

Considerable ill feeling was caused recently when U. S. Navy officials are said to have gone into the holds of ships at U. S. docks and removed machine tools owned by and destined for Japan. This incident resulted in a vigorous protest by the Japanese ambassador. Since then it has become necessary to secure licenses at the State Department for export of machine tools.

With Increased Plant Expansion, Canada Sees Its Labor Shortage Becoming Acute

MONTREAL—New plant construction in Canada for military purposes is now assuming major proportions. To the $120,000,000 of new plant construction that was completed or under way the first of this month, has been added contracts for $10,000,000 while another $40,000,000 worth of new plant projects are planned by the government to begin shortly.

Most of the new construction commitments are very recent—since the capitulation of France. During the first part of this year plant expansion projects amounted to only $30,000,000. However, by the end of June the valuation of new plant construction for war purposes amounted to $110,000,000.

A great deal of the new building projects will provide facilities for the manufacture of munitions, guns, war machines, etc. The scope of the planned expansion indicates that Canada has made speedy industrial progress since relatively few of these products were made in Canada during the last war.

Despite the commendable progress Canadian industry faces a labor shortage which is becoming increasingly acute. Although a population increase occurred since 1929, the labor "reserve" is not more than 10 percent at present. Government financed training schools, operated by provincial governments this summer, will be able to provide several thousand young men for airplane and a few other war plants. However, many more workers will have to be supplied. Some observers indicate that an increased amount of "stealing" trained workers is being done by plants hard pressed to maintain production schedules. An enforced registration of all Canadian manpower, to begin this month, may provide some means to help meet this problem.

Meanwhile in aircraft production 360 airplanes per month are scheduled by the spring of 1941, and a progressively increasing rate is planned thereafter. However, there are no definite plans for motor manufacturing in Canada. For these supplies the government looks to the U.S.

The following companies have been awarded government defense contracts in the past few weeks: MacDonald Bros., Ottawa, $21,485 aircraft; Fleet Aircraft, Ltd., $23,222; Jacobs Aircraft Engine, Pottstown, Pa., $7,941,120; Aviation Electric Ltd., Montreal, $199,214; Weaver Industries, Ltd., Chatham, Ont., $34,881.

U. S. Government Contracts Awarded to Metal-Working Firms

(Defense contracts on page 636j)

Contractor	Gov't Agency	Commodity	Amount
Scovill Mfg. Co., Waterbury, Conn	Ordnance	Cartridge cases	$115,744
Fairbanks, Morse & Co., Chicago, Ill	Navy	Propelling machinery	4,286,811
Ingersoll-Rand Co., New York, N. Y	Navy	Pneumatic tools	36,877
Westinghouse Electric & Mfg. Co., Washington, D. C	Navy	Arc welding machines	32,780
The Baldwin Locomotive Works, Philadelphia, Pa	Interior	Locomotive	85,700
Steuart Motor Co., Washington, D. C	Procurement	Trucks	36,183
International Harvester Co., Washington, D. C	Procurement	Trucks	23,008
Spartan Aircraft Co., Tulsa, Okla	Navy	Airplanes	1,859,880
United Aircraft Corp., Propeller Div., East Hartford, Conn	Navy	Equipment, propeller overhaul	25,983
Sperry Gyroscope Co., Inc., Brooklyn, N. Y.	Ordnance	Directors	2,422,118
Budd Wheel Co., Detroit, Mich	War	Shells	1,243,051
Norwalk Lock Co., New York, N. Y	War	Shot	125,998
Aetna-Standard Engineering Co., Youngstown, Ohio	War	Gun Carriages	3,302,139
Koppers Co. (Bartlett Hayward Div.), Baltimore, Md	War	Gun Carriages	3,725,930
Kilby Steel Co., Anniston, Ala	War	Forgings for Shell	113,228
Line Material Co., Milwaukee, Wisc	War	Shell	104,432

PLANE MAKERS AGREE TO PRODUCE WITHOUT AMORTIZATION GUARANTEE

WASHINGTON—Agreement by all the major plane manufacturers to go ahead, at least partially, on the airplane production program without waiting for action on amortization breaks up a blockade so tight that in seven weeks contracts had been let for only 33 airplanes. Coming two weeks after a hot conference with military and defense commission officials, the present agreement is understood to cover only that part of the program which can be undertaken without actual expansion of plant. The manufacturers are proceeding on the basis of semi-formal assurances that if they don't get firm contracts before a certain date they will be reimbursed for out of pocket costs for tools and dies. The plans cover about 4,000 of the 8,000 planes for which appropriations have been made (19,000 more are in pending appropriations).

There are some exceptions to this hesitant procedure. North American has for some weeks been building and storing trainers, without any definite order. And Douglas, which has been a leader of the group in the industry which wants to play ball with the administration, this week announced plans to start immediately a $20,000,000 plant expansion.

Meanwhile, Knudsen, in effect, has informed the British that by late 1941 U. S. production of actual combat planes, exclusive of trainers, will exceed 1,300-1,400 a month. Production this month, including about 50% trainers, is 900 a month and will reach 1,500 by year-end.

INSIDE DETROIT

Automotive industry plans to increase production for the 1941 model year. Year just closed saw a 23 percent gain in output; optimistic dealer surveys see public's buying power continued

BY RUPERT LE GRAND, DETROIT EDITOR

DETROIT—Buoyed up by a 23 per cent gain in output for the production season just closed, by near-record summer sales, and by optimistic dealer surveys of the public's continued buying power, the automobile industry is laying plans to swing into far heavier initial production than was the case a year ago. Production plans for August and September are still somewhat embryonic because production chiefs can not say exactly at this stage just how many cars will be produced in a given week or month. But every effort is being made to conserve the time gained by relatively short changeover periods, and to reach peak output within a few weeks.

In view of recent attempts by automobile companies to stabilize employment throughout the entire production season, the plans of Pontiac are significant, pointing as they do toward expectations of an unusually good fall. H. J. Klingler, president and general manager, reports that 10,000 new models will be built in August, and 22,000 in September, a gain of over 100 per cent as compared with the same two months in 1939. Pontiac expects a 30 per cent sales increase for 1941, although it built 217,000 cars for an all-time record in the year just ended.

Buick, as reported earlier, has expanded its plant for a total annual capacity of 350,000 cars, whereas it enjoyed an all-time sales high of 282,000 cars during the 1940 season.

Near Capacity Output

Hudson and Packard are nearing capacity output of 1941 models. Studebaker is not quite as well advanced, but should have dealers well stocked by the first of September. Willys will show its new cars to newspaper men on August 16, but two or three weeks will pass before public showings. Nash is probably the latest of the independents, and will not commence assemblies until late August.

Nash has confirmed reports made several months ago that a new car will be offered in the Chevrolet, Ford and Plymouth price class. Company officials stress the fact that a full-size automobile will be offered, not a scaled-down model. The body shell will be the same as used in the Ambassador six and eight, and both of these senior models will feature greater width than provided in the 1940 models. Power plant, wheelbase and fittings will distinguish the three lines.

Thus, Nash hopes that the new car will have the same effect on its fortunes as Studebaker has enjoyed with the Champion. In addition to low price, maximum body size, and an expected wheelbase of 112 in., the junior model will be engined for performance with economy. It is said that preliminary tests have shown a gasoline economy of 30 miles or more to the gallon. For some time Nash toyed with the idea of naming the new car "American", but that idea has been dropped in favor of calling it a Nash with a certain series designation.

Buick Will Build 300,000 Cars

Buick plans to build a minimum of 300,000 cars in 1941 at an expenditure of more than $200,000,000 for materials and supplies alone.

A larger share of the national income is finding its way into the purchase of automobiles. Coincident with Mr. Curtice's outlook for the remainder of this year, the production of 16,000 cars is planned for August, and a total of 130,000 is scheduled for the balance of the year. This figure is 20,000 more than last year, and is the heaviest manufacturing program ever launched by Buick.

In addition to the $10,000,000 spent for retooling and plant expansion, Buick has committed itself for $100,000,000 worth of materials and supplies for the balance of this year. During the entire model year this division will spend over $200,000,000 for the materials and supplies, exclusive of payrolls.

In September Buick will reveal that a new radical tear-drop model with a torpedo width body has replaced the old style special series. Engine outputs have been increased by compound carburetion, improved combustion chamber design and higher compression ratios.

PRIORITIES MAY HURT AUTO MAKERS

DETROIT—The automotive industry is particularly interested to avoid priorities for machine tools, steel, and other commodities. Although leaders in the industry are talking in terms of a four million car year for the 1941 model, whether the realization comes may depend upon how much the defense program interfers with the production plans. Due to the increased employment and purchasing power, the market exists for an increased supply of automobiles, and makers insist that production should not be curtailed because passenger cars as such are not essential to the defense program.

Here They Come—*Half concealing, half revealing, Messrs. O. W. Young, W. F. Jufstader, C. A. Chayne, and Harlow H. Curtice tantalizingly prevent a good look at the Buick Special for 1941. The tear-drop body contour introduced represents a radical change in body types*

U. S. Tank Production Expands as Army Organizes More Armored Motor Divisions

WASHINGTON—No one has yet suggested 50,000 tanks, but it begins to look as if, on a smaller scale tank production might soon attain the same rapid expansion and dramatic intensity as airplane production. The Army is in process of organizing two *panzer divisionen* and more are in prospect. Each of these armored divisions will include 272 light tanks of 12-15 tons each and 110 medium tanks of 15-20 tons plus 181 scout cars—wheeled, armored vehicles primarily for operation on roads. And, of course, large numbers of tanks are assigned to non-armored divisions.

The same financial factors that have delayed plane contracts have held up actual completion of tank awards, but the Defense Commission has cleared orders with American Car and Foundry Co. for over 1,000 light tanks to cost $21,749,000. Also cleared is a contract with White Motor for 500-600 scout cars totalling $5,387,500. Negotiations are under way with Chrysler to build a $16,000,000 plant, government financed, and manufacture about 1,000 tanks.

In line with the usual parallelism of British and U.S. orders, the British purchasing Commission has announced its intention to enter the tank market here and hopes to spend as much as $200,000,000 on 4,000 medium tanks at this time.

The Army, in the past, has tended to favor the lighter vehicles and the 20-ton medium tank has been the heaviest in regular service. Lately experiments with vehicles up to 30 tons have been made.

A more far-reaching change is the decision to introduce heavy tanks—revealed when the Defense Commission distressed the military by telling that negotiations had been completed with Baldwin Locomotive to build $5,690,000 worth of heavy tanks. No details on these have been announced, but the Baldwin order is believed to cover about 50-75 vehicles. Weight is thought to run to about 50 tons, and they probably mount 75 mm. guns. Ordnance officers still feel that the 70 and 80-ton monsters used in the Battle of France are primarily of value for attacking fortifications—a problem they aren't worrying about for the present.

$4,000,000 SPENT FOR TRACTORS

Allis-Chalmers and International Harvester have recently contracted for over $4,000,000 of tractors for hauling U. S. Army artillery. This contract will not cause any disruption to their regular production.

U. S. Government Contracts Awarded to Tool Makers

(Other defense contracts on page 636h)

Contractor	Gov't Agency	Commodity	Amount
International Harvester Co., Inc., Washington, D. C.	Procurement	Tractors	$35,367
Caterpillar Tractor Co., Peoria, Ill.	Procurement	Tractors	28,356
Kearney & Trecker Corp., Milwaukee, Wisc.	Ordnance	Milling machines	51,160
Ex-Cell-O Corp., Detroit, Mich.	Ordnance	Shell turning	52,280
Swind Machinery Co., Philadelphia, Pa.	Ordnance	Planer	19,962
Niles-Bement-Pond Co., Pratt & Whitney Div., West Hartford, Conn.	Air Corps	Radial drills	36,450
The Heald Machine Co., Worcester, Mass.	Air Corps	Cylinder grinders	59,280
Niles-Bement-Pond Co., Pratt & Whitney Div., West Hartford, Conn.	Air Corps	Lathes	87,995
Cincinnati Milling Machine, Inc., Cincinnati, Ohio	Ordnance	Milling machines	128,056
Ex-Cell-O Corp., Detroit, Mich.	Ordnance	Boring machines	15,767
Brown & Sharpe Mfg. Co., Providence, R. I.	Ordnance	Milling machines	107,325
Kingsbury Machine Tool Corp., Keene, N. H.	Ordnance	Machines	20,799
Pratt & Whitney Div., Niles-Bement-Pond Co., West Hartford, Conn.	Ordnance	Precision lathes	38,105
Leland-Gifford Co., Worcester, Mass.	Navy	Drilling machines	25,951
Austin-Hastings Co., Inc., Cambridge, Mass.	Navy	Planer-shapers	22,862
Browning Crane & Shovel Co., Cleveland, O.	Panama Canal	Cranes	199,200
Jones & Lamson Machine Co., Springfield, Vt.	War Ordnance	Shell turning machines	41,461
Austin-Hastings Co., Inc., Cambridge, Mass.	Ordnance	Planers	51,837
Bay State Tool & Machine Co., Springfield, Mass.	War	Parts for rifles	34,136
W. E. Shipley Machinery Co., Philadelphia, Pa.	War	Screw machines	22,215
Austin-Hastings Co., Inc., Cambridge, Mass.	War	Turning lathes	60,000
The Bullard Co., Bridgeport, Conn.	War	Boring mill	20,467
Sebastian Lathe Co., Cincinnati, Ohio	War	Lathes	36,851
C. F. Bulotti Machinery Co., San Francisco, Calif.	Navy	Twist drills	45,784
Worthington Pump & Machinery Corp., Harrison, N. J.	War	Pumps, engines	38,089
Gisholt Machine Co., Madison, Wisc.	Navy	Turret lathes	14,604
Brown & Sharpe Mfg. Co., Providence, R. I.	War	Milling machines	50,541
G. A. Gray Co., Cincinnati, Ohio	War	Planers	43,884
Kearney & Trecker Corp., Milwaukee, Wisc.	War	Milling machines	49,868
Monarch Machine Tool Co., Sidney, Ohio	War	Lathes	36,012
Cincinnati Milling Machine Inc., Cincinnati, Ohio	War	Milling machines	23,491

TOOL BUILDERS, REFUSED EXPORT LICENSES, TO GET RFC ADVANCES

WASHINGTON—Arrangements have been completed whereby the Reconstruction Finance Corporation will advance 90 per cent of the selling price of machine tools to the builders where export licenses for such machines have been refused. The only provision is that such machine tools should be suitable for national defense purposes.

The program is also designed to act as a cushion in case the European war should suddenly end. It would enable machine tool builders with large British orders to continue production without interruption during a time when the U. S. Government would be arranging to take over such orders for delivery to U. S. plants working on defense contracts.

To secure payment for his completed machines, the builder must present to the R. F. C. a warehouse certificate showing that the units are in storage ready for delivery to whatever point the government may designate. It is understood that military authorities now are arranging for certain warehouses at key points to be tied in with the plan. Before a company can secure payment of 90 per cent of the price it must obtain from the army and navy Munitions Board a certification that the specified machines are essential to national defense.

Largest Japanese Investment Made In Machinery and Tool Industry

TOKYO—More capital is invested in the Japanese machinery and tool industry than in any other Japanese manufacturing business. At the end of March, this year, the total investment in the industry totaled approximately $703,794,000, while during the month of May alone expansions in the machinery industry included approximately $17,372,000 in capital increases and $621,000 of newly authorized share capital.

At the same time, the Cabinet Bureau of Statistics has disclosed that employment in the machinery industry has increased 102 per cent since July 1937. No other industry in Japan can boast a larger labor force.

Meanwhile Japanese exports of machinery of every description reached a record total approximating $33,600,000 during the first four months of 1940. Exports in the same grouping during the corresponding periods in 1939 and 1938 were approximately $22,000,000 and $14,500,000. The average unit price of metal working machines was $345.

Many observers indicate that Japanese imports of machine tools, parts and accessories have decreased measurably.

NAMES in the NEWS

O. E. Hunt, vice president and member of the administration committee of General Motors Corporation, was elected a member of the policy committee, with specially assigned duties. H. H. Curtice, vice president of the corporation and general manager of the Buick Motor Division of General Motors, was elected a director of the corporation to succeed Seward Prosser, who recently resigned. At the same time C. L. McCuen, general manager of the Olds Motor Works Division of General Motors, was elected a vice president of the corporation and transferred to the central office, in charge of engineering activities.

Meanwhile other changes occurred as S. E. Skinner, general manager of Ternstedt Manufacturing Division, became general manager of Olds Motor Works Division. J. W. Jackson, formerly works manager succeeds Mr. Skinner as general manager. F. C. Kroeger, general manager of Delco-Remy Division was appointed general manager of Allison Division. O. V. Badgley, factory manager of Delco-Remy Division, has been appointed general manager.

Major Austin C. Taylor and George W. Sweny have been appointed directors of the Boeing Aircraft Co. of Canada, Ltd.

M. J. Tannes, Jr., A. H. Williams, and Ray P. Tennes, have been elected president, vice president and secretary respectively of Schafer Bearing Corp., Chicago, Ill.

Col. L. B. Lent, has been appointed executive secretary of the American Engineering Council to succeed Frederick M. Feiker.

Roy A. Watkins has been appointed works manager in full charge of manufacturing for Beech Aircraft Corp., Wichita, Kans. Formerly Mr. Watkins had been production engineer of Lockheed Aircraft Corp.

August H. Tuechter, president, the Cincinnati Bickford Tool Co., has recently celebrated his 55th anniversary as a member of the organization.

Henry K. Beebe, who had been superintendent of the Buffalo Ford plant for five years and also a traveling superintendent for the Ford Company, has been appointed plant engineer at the Bell Aircraft Corp. in Buffalo.

Charles J. Marks has been appointed chief tool engineer of the United Aircraft Corp. At the same time Arthur A. Merry and Frederick L. Woodcock were appointed to the positions of chief tool engineer of Pratt & Whitney Aircraft Division and Hamilton Standard Propellers Division respectively.

Has Special Duties

O. E. HUNT

New Director

H. H. CURTICE

Elected Vice President

C. L. McCUEN

Craig Hampton, formerly connected with the Steel & Tube Division of Timken Roller Bearing Co., is now superintendent of maintenance at Copperweld Steel Co.'s new plant at Warren, Ohio.

M. A. Carpenter has been elected executive vice president and a director of the Falk Corporation, Milwaukee, Wis.

Harold Caminez, connected for many years with Allison Engineering Co., has been appointed executive engineer of Air Associates, Inc.

Charles R. Miller, Jr., has been named director of purchases of the United States Steel Corp. of Delaware. He takes over the duties of Charles H. Rhodes, vice president, who has recently been transferred to Chicago.

W. H. Milton, Jr. who has been sales manager for the General Electric plastics department at Pittsfield, Mass., has been appointed assistant manager.

BUSINESS ITEMS

American Textile Engineering, Inc., Kearny, N. J., and its affiliated corporations, for so many years makers of textile conditioning machinery and liquids, have merged into a new corporation, Kearny Mfg. Co., Inc., with offices and shops at Kearny, N. J. and Greenville, S. C.

Springfield Electric Motor Co., Springfield, Ohio, has been appointed a distributor for General Electric Automotive Products.

Frederick Colman & Sons, Inc., manufacturers of tools, dies and special machinery for the automotive and aviation industries, will soon begin construction of a new $150,000 addition to its plant at Detroit, Mich.

Moves to Allison

F. C. KROEGER

With Olds Motor Works

S. E. SKINNER

C. C. Kordenbrock, formerly with Lodge & Shipley Machine Tool Co., has just become associated with the Kordenbrock Machinery Co., Detroit, in the capacity of sales engineer.

F. A. Guiberson, Jr. and F. A. Guiberson, III, developers of the radial diesel engine, which is now being used in army tanks, have moved from Dallas, Tex. and opened offices at 310 S. Michigan Ave., Chicago, Ill.

Vultee Aircraft Co., Inc. will be acquired by the Stinson Aircraft Division of the Aviation Manufacturing Corp. by an exchange of stock.

Robert E. Prill, formerly with W. J. Holliday & Co., and others, has now established the Practical Welding Engineering Service at Chicago, Ill. Assistance and consultation service on welding procedures is offered.

Equipment Steel Products Division, Union Asbestos & Rubber Co., has purchased the galvanizing plant of the Rogers Galvanizing Co. at Blue Island, Chicago.

The Chain Belt Co. of Milwaukee, Wis. has just completed moving the manufacturing operations of its screw conveyor and light steel bucket division from its Chicago plant to West Milwaukee works of the company.

Browning Tool & Supply Co., Indianapolis, Ind., has been appointed exclusive representative in Indiana for the Geometric Tool Co., New Haven, Conn.

PLANT EXPANSION

Scheduled to be completed in three months is a new $260,000 addition to the plant of the Harrison Radiator Division of General Motors Corporation which was recently begun at Lockport, N. Y.

SKF Industries, Inc., Philadelphia, Pa., has purchased the Watson Shock Absorber plant in that city. The new acquisition, which contains 226,000 sq.ft. of floor space, will be devoted exclusively to the manufacture of anti-friction bearings.

A new plant being constructed by Air Associates, Inc. at Bendix, N. J., is near completion. The total floor area of the new building is 63,000 sq.ft.

A $2,000,000 plant addition is being completed for Boeing Aircraft Co. at Seattle, Wash.

Construction has started on the new $400,000 plant of the United States Electrical Motors, Inc. of Los Angeles, in Milford, Conn. The new building, a one-story structure, will cover about 50,000 sq.ft. of floor space.

At an approximate cost of $6,500, the J. W. Hewitt Machine Co., Neenah, Wis., is scheduled to erect an addition to its plant.

Hydraulic Press Mfg. Co. plans to build a new plant at Mount Gilead, Ohio. The building is to be 400 ft. long and construction operations are expected to be under way in September.

At a cost of approximately $9,000, Allis-Chalmers Mfg. Co. will add a 24x26 ft. shop addition to its West Allis, Wis., plant.

Byron Jackson Co., pump manufacturers, of 2150 Slauson Ave., Los Angeles, Calif., will erect a new pattern shop, at Huntington Park, Calif., at a cost of $65,000.

OBITUARIES

Stanley P. Rockwell, 54, vice-president Stanley P. Rockwell Co., Hartford, Conn., was killed by an explosion aboard his cabin cruiser Aug. 11.

Killed in Accident

STANLEY P. ROCKWELL

Mr. Rockwell was one of the leading metallurgists of the country and the inventor of a hardness tester and dilatometer which bear his name. He also was the recipient of the Sauveur Achievement Award in 1939. He entered business for himself in 1920.

Carl F. Anderson, 73, president of Anderson-Shumaker Co., Chicago, Ill., has died. Mr. Anderson who organized his steel and iron works company in 1902, was also vice president of a Swedish engineers society.

Donald M. Smith, assistant district sales manager in the Chicago office of Allegheny-Ludlum Steel Corp., Pittsburgh, Pa., died recently at his residence in Chicago.

Karl W. Johnson, 78, president of the Commonwealth Screw Co., Worcester, Mass., died at his home in that city recently.

Adam A. Breuer, president and founder of the Breuer Electrical Mfg. Co., Chicago, Ill., has died at the age of 57. Prior to the organization of his own company in 1927, Mr. Breuer was with International Harvester Co. and with American Steel & Wire Co.

Jacob D. Ginther, 90, former vice president and general manager of Washington Iron Works of Buffalo, N. Y., died August 6.

William A. James, 69, chief engineer of the Lackawanna plant of Bethlehem Steel Corp., died suddenly August 2 while on a brief vacation. Mr. James had been connected with the steel plant since 1901.

Russell Harry Palmer, president of the National Machinery Co. at Vancouver, B. C., has died.

John Lowell Fyke, 55, general superintendent of Allis-Chalmers Mfg. Company's electrical and steam turbine shops, died recently.

Herbert W. Wolff, senior vice president, American Car & Foundry Co., died recently at the age of 67. Mr. Wolff had been associated with the company since 1899 when he was chief mechanical engineer.

MEETINGS

American Gear Manufacturers Association. The 23rd semi-annual convention, Skytop Lodge, Skytop, Pa. October 14, 15 and 16, 1940.

Porcelain Enamel Institute. Fifth annual forum, University of Illinois, Urbana, Ill. Oct. 16–18.

Society of Automotive Engineers. National tractor meeting, Schroeder Hotel, Milwaukee, Wis., Sept. 24–25. Annual dinner, Hotel Commodore, New York, N. Y., Oct. 14.

American Institute of Electrical Engineers. Pacific Coast convention, Los Angeles, Calif., Aug. 26–30.

American Society of Mechanical Engineers. Fall meeting, Spokane, Wash., Sept. 3–6.

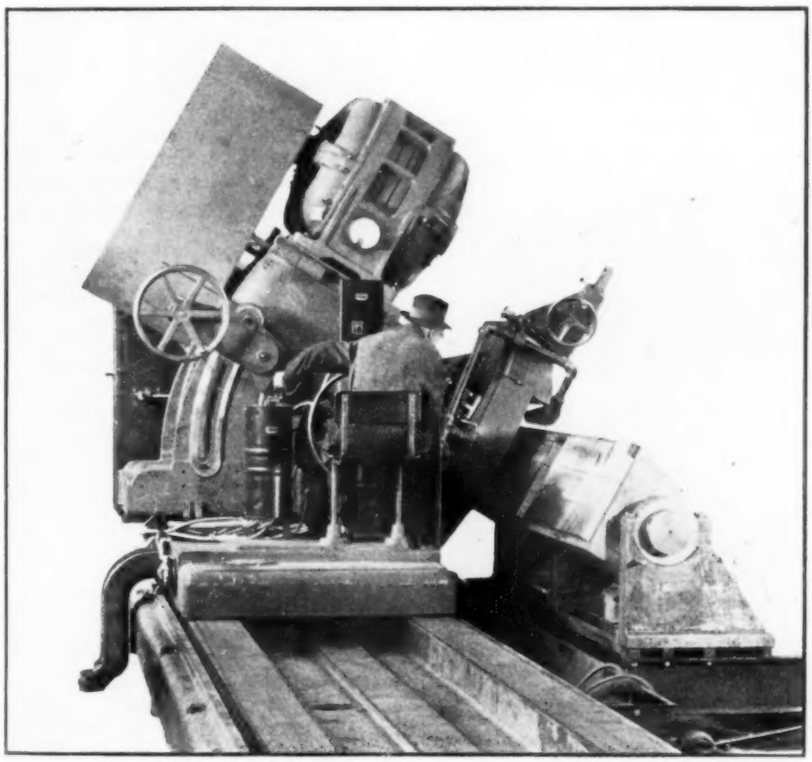
SHOP EQUIPMENT NEWS

Hanchett Travelling Wheel Face Grinder Designed to Finish Edges of Armor Plate

The No. 700 travelling wheel face grinder developed by Hanchett Mfg. Co., Big Rapids, Mich., has been built specially for finishing edges of armor plate, having a capacity for grinding plates 10 ft. wide, 45 ft. long, and up to 20 in. thick.

Grinding wheel is of the segmental type, 48 in. in diameter. Each abrasive block has a 4x8-in. grinding face. Grinding wheel spindle, 8 in. in diameter, is mounted on Timken tapered roller bearings, and is driven through V-belts from a 125-hp. motor. Wheelhead has hand, power and automatic cross feed, and can be adjusted from the vertical to an angle of 30 deg. Wheel carriage travels on one V-way and one flat way, each 6½ in. wide, by means of a bull gear engaging a rack attached to the machine bed. This feed mechanism is driven through a 15-hp. reversing motor with controls for providing variable speeds. Ways and rack are protected with belt covers, and are lubricated with a forced feed system.

Grinding is done wet. A 1-hp. centrifugal coolant pump is attached to a bracket at the left of the carriage. This coolant pump travels along a channel-shaped coolant tank and delivers coolant onto both the wheel and work. Current is supplied to the various units on the machine by bus bars and brushes completely inclosed in a cast iron guard attached to the rear of the bed. Complete machine without work table weighs approximately 75,000 lb.



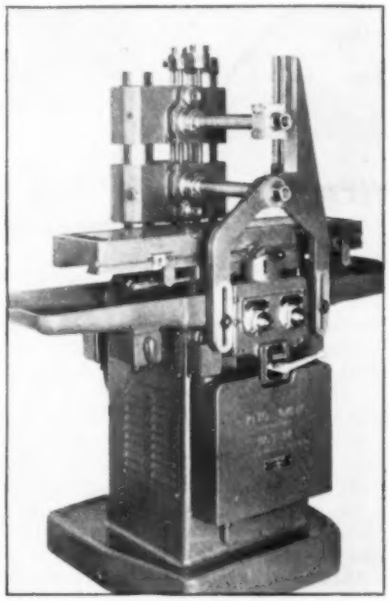
Double Spindle Milling Machines Split Bushings, Mill Piston Slots

Kent-Owens Machine Co., Toledo, Ohio, has introduced a line of milling machines equipped with double spindles, especially suited for splitting bushings, milling slots in pistons and other similar operations. They can be used on a wide variety of other parts having two or more surfaces spaced from each other and which can be milled to advantage by using two cutters mounted on different spindles.

Spindles are adjustable vertically and independently of each other by means of screws having micrometer dials. Center distance between the two spindles is 4¾ in. minimum and 11 in. maximum.

Center of the lower spindle can be brought to within 1 in. of the table surface, and center of the upper spindle can be raised to 12 in. above the table surface. Each spindle is independently adjustable horizontally. This adjustment is 1½ in. and can be accurately controlled by means of micrometer dials.

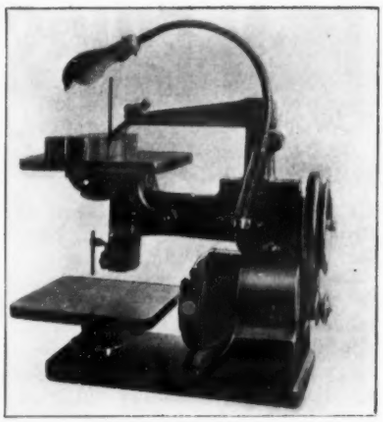
Spindle heads are supported on two ground cylindrical steel posts. Drive is from a standard foot mounted ball bearing motor at the rear. Machine is furnished complete with spindle drive motor, hydraulic pump motor, all hydraulic equipment and all electrical equipment.



Two panel dials control the table feed from ½ to 80 in. per min., one dial being used for fine feeds, the other for coarse. Shown in the illustration are double spindles mounted on the No. 1-14 hydraulic milling machine. This machine has a 14-in. table travel and a 9x32 in. table. Double spindle arrangement can also be applied to the Nos. 1-M and 1-8 machines.

Duplex Punch and Die Filer Has Universal Tilting Table

A combination bench-type double-purpose filing machine, distributed through Marburg Brothers, Inc., 90 West St., New York, N. Y., has been



built especially for finish filing punches and dies. Among its features are (as a die filer) table which tilts to any compound angle, stroke fully adjustable from 0 to 1½ in., file fully supported over entire stroke, and (as a punch filer) table which tilts 10 deg. two ways, stroke fully adjustable to suit punch flange, automatic stopping of file.

When the unit is used as a die filer, the upper table is swivelled into working position for the conventional type of filing. The file holder operates from below and the file penetrates the die. When used as a punch filer, the upper table is tilted out of the way and the lower table is then ready for filing. The punch file operates from the top but does not penetrate the table. Instead, the file movement is accurately controlled by an adjustable stroke.

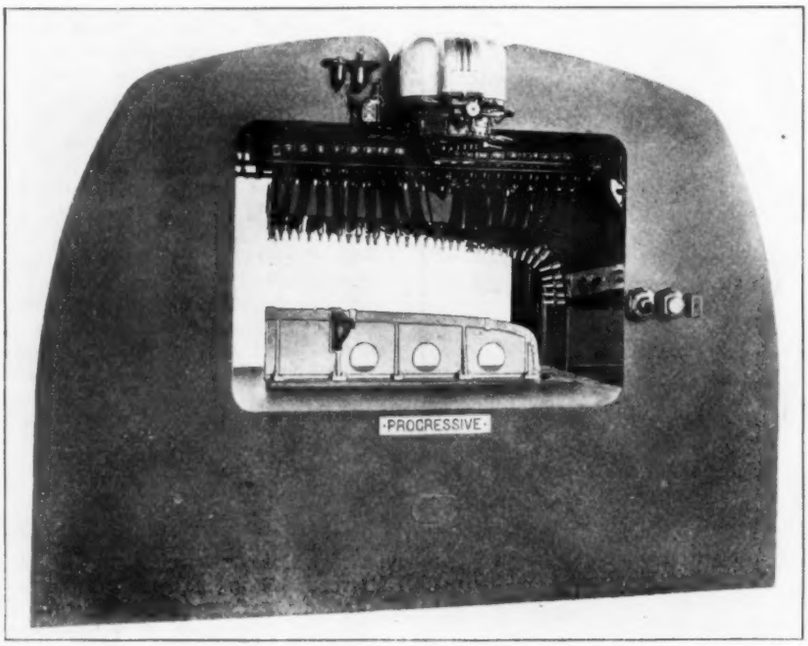
Both tables, 10 in. square, are accurately ground. File support is of a recessed design, and file holders are guided in prismatic ways with adjustable gibs. Crank drive with a range of 0–1½-in. stroke can be used as a permanent drive, or set as a friction drive incorporating a safety clutch which automatically stops the stroke should the file hit an obstruction.

Regular machine files can be used on the device. Standard equipment includes a ¼-hp. 110 volt a.c. motor located inside the frame and two-step pulley V-belt drive.

"Progress-O-Matic" High Speed Spot Welder Produces More Than 6,000 Welds per Hour

Capable of making upwards of 6,000 spot welds per hour, the "Progress-O-Matic" high speed spot welder announced by Progressive Welder Co., 3001 East Outer Drive, Detroit, Mich., is claimed to produce better welds than possible with conventional welding equipment of even lower production capacity. This machine, the first of which is now in operation on 1941 automobile body work, uses a method of current transfer which makes and breaks the secondary as well as the primary circuit, thus giving the machine such flexibility of operation that it can weld an assembly having several thicknesses of metal.

With the new design, all welding points are brought down on the work under full pressure and held there throughout the entire welding cycle. Since points are already on the work before the current is on and remain there after the current is off, chance of burned welds is virtually eliminated. Machine is provided with quickly interchangeable lower electrodes to accommodate different size assemblies. Model illustrated makes 36 spots to join the two halves of two sizes of automobile hood tops.



In operation, pieces are loaded into the machine from front and back. Operator then touches control button to raise work to welding position. This is accomplished through four air cylinders. At the end of their stroke an automatic valve is tripped and additional cylinders superimpose a wedging support for the central portion of the work table. All welding points are thus effectively brought up to the desired predetermined pressure. Machine then automatically begins its welding cycle. When completed, the table returns to open position and the work is unloaded through one end of the machine.

The new design permits such rapid distribution (timing) of current that only one transformer is required. A ¼-hp. air motor drives an indexing disk which has a single port near its edge. Synchronized with the operation of this disk are two automotive-type distributors. When the port in the disk comes into alignment with a similar port in the timing chamber, it permits a charge of air to close one of the contact guns. This gun closes a secondary connection between transformer and work.

Welding current circuit flows through one gun, through the lower electrode, and up through another gun. Thus two welds are made at once, in series. All 36 welds are made during one complete revolution of the timing disk.

Each air-operated contact gun consists of a cylinder with two split pistons, the upper piston being cut diagonally. When air from the timing port enters this chamber it forces the piston down, to establish contact with a bus bar and also forces the piston to one side to make positive contact with the side of the cylinder. The latter is connected with its respective welding point. Connection is broken by a return spring.

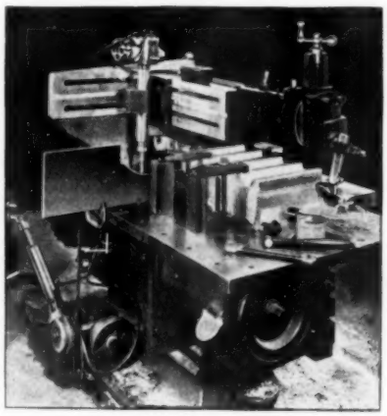
All welding points can be adjusted to a predetermined pressure by means of high-pressure springs. A calibrated scale on each welding gun permits direct reading of pressure. Timing method permits timing up to 24 cycles; sufficient, it is said, to handle the heaviest type of high-production work now being welded. Interrupted timing, also a requisite for extremely heavy duty welding, is also possible through a few changes in the timing mechanism.

Automatic Form Shaping Possible with Duplicator

Automatic form cutting with a shaper through the use of a form duplicating control utilizing a simple die duplicator produced by the Detroit

Universal Duplicator Co., 249 St. Aubin St., Detroit, Mich., is said to permit considerable saving of cost and time. A typical application which arose recently was the problem of machining the sides of magnesium crankcase and barrel core boxes to provide for the application of steel wear plates.

Normally such a job would be milled with frequent checking, at a floor-to-floor time of roughly three hours per piece. However, with the die duplicator hooked up to the shaper and a template provided, machining time was reduced to about 30 minutes, at a saving of some 80 per cent. Checks indicate that a consistent accuracy of within 0.002 in. can be maintained.

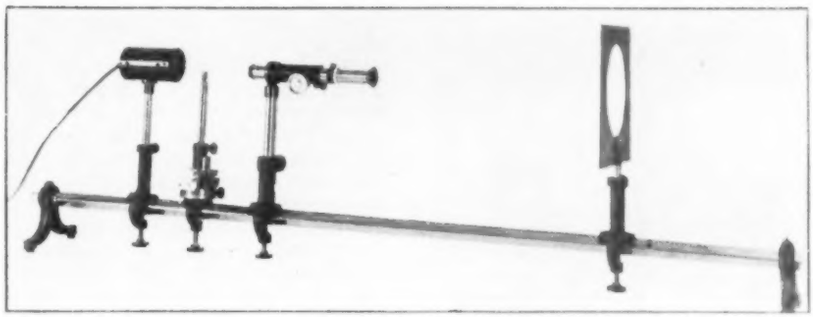


Steel template is mounted on machine table. A tracing finger, supported by a tracer head mounted with a bracket on the shaper, follows the contour of this template, controlling vertical feed, while transverse feed is automatically governed by the setting of the shaper. Work itself is clamped in duplicate to the table so that several pieces can be machined at one time.

Versatile Projection Comparator Uses Standard Optical Parts

Using standard optical bench parts, such as are frequently employed in research laboratories, a projection comparator offered by Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill., provides magnification of 50 times or more. Cost is low, parts are interchangeable so that other equipment may be added as desired, and individual parts such as microscopes, high power lamps, etc., can be put to other important uses in the shop.

Projector consists of a high powered lamp operating from a 6-volt transformer, which shines light into the horizontally mounted microscope. At the end of the unit is the ground glass screen on which the image appears. Between light source and microscope is mounted a standard swivel clamp holding a rod having its upper end threaded, to which can be attached a small platform with centers, V-block, or other methods of holding the object.



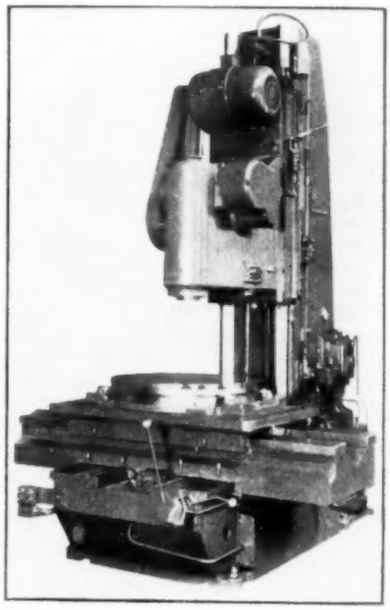
In operation, the part to be examined is placed in an object holder improvised by the user on top of the vertical rod in the swivel clamp, and the clamp moved back and forth in front of the microscope until an image of the object is focused on the screen. Final focusing can be accomplished by the rack and pinion on the microscope. For measurement of screw threads, the swivel clamp is rotated to correspond with the helix angle.

Image is clearly visible in a well-lighted room, but for best results screen should be shielded from direct light. In place of the ground glass screen, translucent drawings can be substituted with which the object can be compared. No refocusing is necessary. A standard microscope will give magnifications up to about 50 times, and it is possible to obtain greater magnifications by interchanging microscope objectives.

Moline Single-Spindle Boring Machine Uses Hydraulically Actuated Table Motions

Hydraulically actuated motion of the table in conjunction with hydraulic feed of the spindle carriage is one of the unusual features of the No. HF-145 single-spindle boring machine built by Moline Tool Co., Moline, Ill.

Boring spindle of this machine is mounted in heavy roller bearings, and is driven through a set of quick change gears, adjustable for four different spindle speeds ranging from 26 to 84 r.p.m. Feed of the boring spindle is hydraulic and can be set for automatic operation, or can be controlled by hand, if desired.



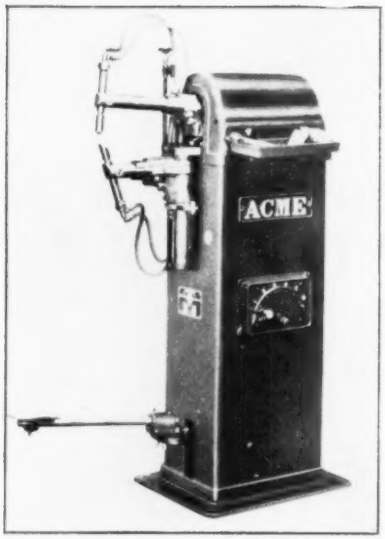
Rectangular work table is movable by hydraulic pressure at either the rapid traverse or feed rate, toward or away from the machine column and to right or left. Machine illustrated is equipped with a round, rotatable T-slotted table which can be set on the rectangular work table when required.

Hand lever used to control vertical travel of the boring spindle carriage is also used to control motions of the table. Only one of these motions can be operative at any time because of mechanical interlocking of valves in the hydraulic circuit. A three-position selector lever is provided which is set to determine which of the three motion-producing hydraulic cylinders will be connected to the hydraulic feed unit. Feed travel for any of the hydraulic motions can be varied from zero to maximum by a small lever which is linked to the volume control lever of the hydraulic unit.

Vertical spindle carriage travel is 36 in., table travel to and from column is 20 in., table cross travel is 40 in., and distance from floor to surface of rectangular table is 36 in.

Acme "Hot Spot" Welders Permit Quick Horn Changes

An improved line of "Hot Spot" foot-operated rocker arm type spot welders has been made available by Acme Electric Welder Co., 5621-23 Pacific

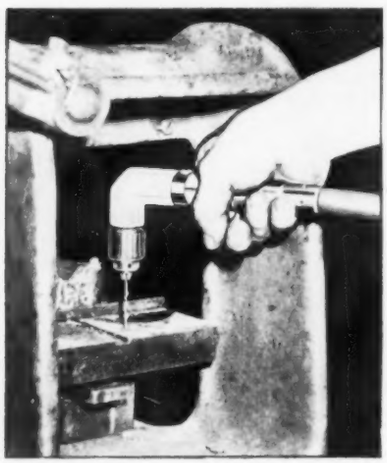


Blvd., Huntington Park, Calif. The Type O machine with stationary lower horn holder and the Type 1 with swivel lower horn holder are manufactured in 10, 15 and 20 kva capacities, and in throat lengths of from 12 to 36 in. They are furnished complete with water cooling equipment.

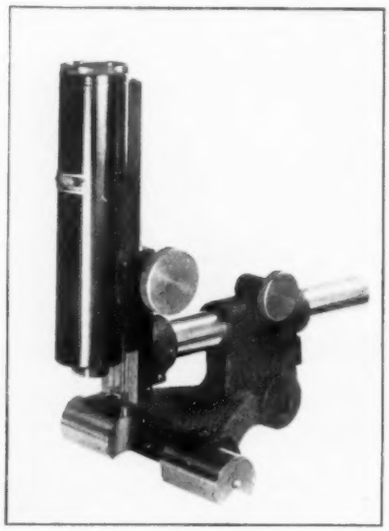
A clamping block device retains the horns in the horn holders with ideal electrical contact, yet half a turn of a ⅝-in. setscrew instantly releases them for a change of set-up. Horns are universal double end reversible, with one end machined to hold electrodes at an angle of 90 deg. and the other end taking electrodes at a 22½ deg. angle.

Angle-Head Attachment Features Compact Case

A close-corner angle-head for use in drilling and filing with flexible shaft machines has been made available by Stow Mfg. Co., Binghamton, N. Y. Compact dimensions of this unit make it usable in very confined quarters. Over-all dimension from the drill socket to the top of the case is only 2⅛ in., while that from the spindle center to the outside of the case is but $\frac{9}{16}$ in.



This unit has an aluminum housing containing two single-row ball bearings, back to back, on the vertical spindle, and a single-row ball bearing combined with a needle bearing on the horizontal spindle. With this equipment, high thrust capacity is achieved. With a chuck screwing onto the vertical spindle, the attachment will accommodate drills, files, etc., with shanks up to ¼ in. For closest work, short drills with $\frac{3}{16}$ in. shanks may be inserted directly into the spindle and held by a setscrew.



Optical Thread Tool Gage Permits Rapid Checking

Rapid yet accurate set-up of single point threading tools is made possible by an optical thread tool gage developed by Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill. This instrument, which also serves for checking tool and thread angles, consists of a specially mounted microscope with an unusually large eyepiece field of ⅞ in., in which appear the characteristic angles of American National Standard, Whitworth, and metric threads. Microscope, which has rack and pinion focusing, is mounted on a keyed cross-rod which slides for adjustment in a reamed hole perpendicular to a mandrel in the base.

For setting up the threading tool perpendicular to the axis of the lathe centers, the female centers of the instrument mandrel are placed between the lathe centers and the cross-rod adjusted until the point of the threading tool is in the field of the microscope. Threading tool is then adjusted in the toolpost until its outline coincides with the corresponding angle in the microscope. In this way, the thread tool will be set perpendicular to the lathe center axis within 2 min. of arc. The angle of the tool itself is checked to the same accuracy.

To check thread angles on work, gage is simply placed on top of the work and the cross-rod of the instrument slid out until the thread appears in the field of the microscope. Accuracy is greater for small leads. A V ground in the bottom of the mandrel facilitates positioning it.

The instrument is suitable for work from ⅜ in. to 6½ in. in diameter. Magnification is about 12 times. It is supplied with a hardwood instrument case.

Toledo Ratchet Threader Permits Rapid Die Changes

A feature of the "Simpact" self-contained 1- to 2-in. ratchet threader offered by Toledo Pipe Threading Machine Co., Toledo, Ohio, is that the high-speed steel dies are quickly changed from one size to another simply by pushing the size selector buttons and slipping the dies in the proper steps. Thus approximately half the time usually required to change sizes is said to be saved.

Dies are backed by tapered steps, so that smooth, long tapered threads are assured. A three-jaw rear gripping device is employed. It is equipped with three broad-faced chuck

jaws, graduated guide posts, and large winghead thumb screws to assure accurate centering of the tool on the pipe. The 24-in. tubular steel handle is strong and light, and the tool is said to be lighter than any other self-contained model. Dies are deep throated and may be resharpened many times.

Greenlee Hand Tube Benders Make Bends Without Flattening

Greenlee Tool Co., Div. of Greenlee Bros. & Co., 12th St. & Columbia Ave., Rockford, Ill., has added a line of hand-operated steel tube benders to its line of hydraulic benders. Developed to meet the requirements of

speed and accuracy in the bending of steel, copper, brass, and other tubing, as used in the machine tool, aviation, air conditioning, and refrigeration industries, these benders feature a design which is claimed to permit the bending of tubes with-

out kinking or flattening. Bending is done by rolling action, rather than sliding, which minimizes friction and leaves the finish of the tube unmarred.

Six sizes are available for bending tubes having outside diameters of ¼, 5/16, ⅜, ½, ⅝, and ¾ in. All are claimed to make smooth, even bends to a center line radius of 2½ times the outside diameter of the tubing. Benders are ordinarily held in a vise, but a tapped hole in the head permits using an auxiliary handle for bending small sizes or soft tubing without a vise.

"Nuggies" Wrench Set Comes in Plastic Case

By using a high grade steel known as "Hexite", Blackhawk Mfg. Co., 5025 W. Rogers St., Milwaukee, Wis., claims new compactness and strength for a line of midget socket wrenches. These wrenches, called "Nuggies", have a ¼ in. square drive. Socket

sizes range from 3/16 in. to 7/16 in.

Miniature "half and halfs" (combination open end and box type wrenches) accompany the midget socket wrenches in the new 18ND set which is furnished in a 5½ x 3 9/32 in. red and black plastic container that slips into the coat pocket. The "half and halfs" have openings from 7/32 to ⅜ in.

Having a polished chromium finish, these tools are designed for professional work on carburetor, magneto, ignition, radio, airplane and other delicate jobs involving small assemblies. They are supplied in an attractive pocket-size two-color container of Durez plastic.

"Porto-Power" Units Now Offered in Sets

A number of improvements in the line of "Porto-Power" hydraulic equipment offered by Blackhawk Mfg. Co., 5025 W. Rogers St., Milwaukee, Wis., has made possible the assembly of a complete ram kit containing 4, 7 and 20-ton rams, plus a special coupler for present owners of the 10-ton hydraulic unit. This coupler, known as the "Spee-D-Coupler" makes it possible to connect the same pump and hose to any one of these rams. Coupler, which joins the high-pressure hose to the ram, seals an oil channel that transmits

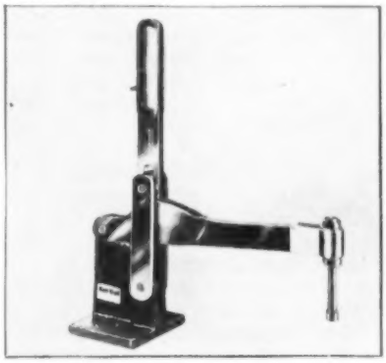
10,000 lb. per sq. in. pressure. Yet it can be disconnected with a twirl of the finger.

A new "Porto-Power" development is a thimble-size 4-ton ram which is only 1⅝ in. in height and diameter. This ram has been created to exert pressure in remote assemblies where large-size tools or hands cannot be inserted. It can be fed into small openings or channels because it is operated remotely on the end of an 8-ft. hose when assembled with the pump.

Another new attachment in the "Porto-Power" line is the "Duck-Bill" spreader which adapts the plunger action of the 10-ton ram to spreading sheet metal and other assemblies. The jaws spread from 1½ to 6 in.

Cam-Action Toggle Clamp Handles Various Stock Sizes

The "Knu-Kam-Klamp" cam-action toggle clamp offered by Knu-Vise, Inc., 16841 Hamilton Ave., Detroit, Mich., overcomes the disadvantage of standard toggle clamps by permitting the clamping of more than one thickness of stock at one set-up. The adjustment range is from ⅞ to 1 in.,

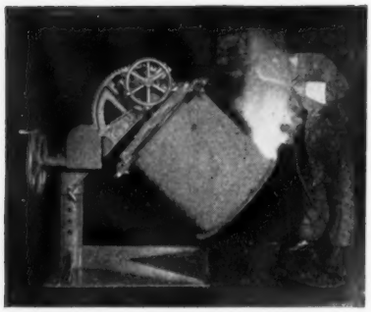


depending on the portion of the toggle bar used for clamping.

Clamp is made in two sizes, both interchangeable with the standard Type 110 and 250 toggle clamps. Action is similar to that of a toggle clamp in that both types have a clamping bar hinged at one end, an operating handle, and a base member for attaching to the fixture. Link connecting handle to toggle bar is slotted to permit this bar to be rapidly withdrawn from the work, but plays no part in the clamping operation. Upper portion of the toggle or clamping bar is machined to a cam surface against which two rollers are in contact at all times. When the handle is vertical these rollers contact the low part of the cam surface and the toggle bar is in position to take the thickest part being held in the fixture. Continued swinging of the handle forces these rollers against the cam rise so that the bar is in the minimum clamping position.

C-F Welding Positioner Revolves Through Full Circle

Recently added to the line of welding stands offered by Cullen-Friestedt Co., 1300 S. Kilbourn Ave., Chicago, Ill., is the Model 12 positioner with



a capacity of 1200 lb. Like other positioners of the line, this model can be tilted a total of 135 deg. from the horizontal, and the table can be revolved through a full circle regardless of the angle of tilt.

Table is removable for attachment of special jigs or fixtures and is adjustable in height. By mounting the positioner operating mechanism on a special base, extremely large and bulky work can be fully rotated when tilted without any interference from floor or pedestal mounting.

This unit can be furnished fully powered with independent motor and controls for table tilt and table rotation. Power for table rotation can be furnished with either constant or variable speed drive. It can also be furnished for manual operation with independent handwheel for table tilt and table rotation, or a combination of manual and power operation.

It is claimed that the universal table adjustment of this positioner reduces the number of passes required, reduces rod consumption and assures better welds by permitting all work to be done in a horizontal trough. Much welding, hoist and crane time is saved by positioning assemblies, and, with variable speed power operated table rotation, rod may be held in one position while work is rotated at proper welding speed. Table is self-locking in any position.

Flex-Arc Portable Welder Designed for General Service

A modern all-purpose portable a.c. welder designed for all-round general utility service and production welding has been developed by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Standard models operate on either 220 or 440 volts, are completely self contained, and incorporate several distinct new design features.

From 20 to 250 amp. of welding current is available in 27 steps, with increments properly proportioned to meet the needs of welding with a wide variety of electrodes. A built-in "De-Ion" circuit breaker insures protection against sustained overloads. Open circuit voltage is exceptionally low, being on the order of 80 volts at 20 amp., and ranging down to 50 volts at the highest current rating.

Welder is completely self-contained, being inclosed in a steel case mounted on three wheels. High efficiency, high power factor, and low no-load losses

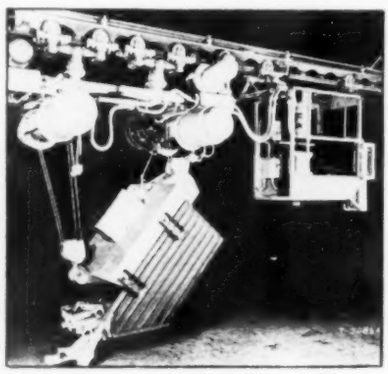
insure maximum operating economies. It is furnished complete with all accessories, including welding helmet with lens, electrode holder, all leads, and a 17-lb. assortment of electrodes.

Cleveland Tramrail Carrier Lifts, Carries, Empties Boxes

Cleveland Tramrail Div., Cleveland Crane & Engineering Co., Wickliffe, Ohio, has developed a tilting box grab and tramrail carrier that picks boxes up, sets them down, or empties them by tilting; all operations being manipulated by controllers in the cab.

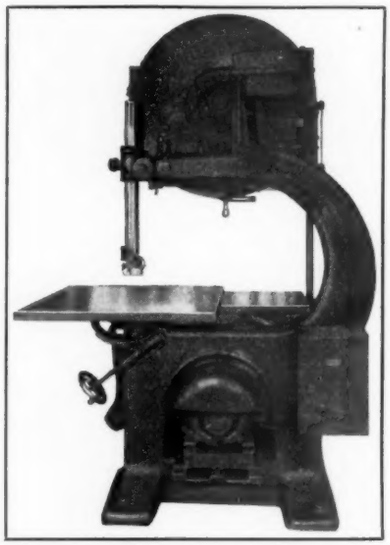
Equipment consists of a cab-operated motor-driven carrier with two independent hoisting units and motorized grab. It is possible to raise or lower boxes as desired and empty them as fast or as slowly as may be required.

Boxes used with the grab are provided with four suspension brackets, two on each side. Motor-driven sliding latch bars in the grab may be



extended into or retracted from the suspension brackets by the operator. In operation the grab is passed between the suspension brackets and stopped at proper position by heel of grab which is brought against end of box. Even at distances of 30 or 40 ft. below the carrier, boxes can be picked up or spotted easily and quickly. No floor men are required. Suspension brackets make it possible to interlock the boxes, thus facilitating stacking in even tiers.

Unit illustrated was designed for handling 3 tons, although units of any size up to 5 tons may be furnished. Carrier travels on arch-beam rails at 300 ft. per min. Tote boxes, spool boxes and other containers may be handled with this equipment.



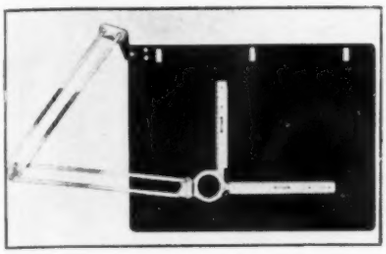
Tannewitz Bandsaw Eliminates Hazards of Broken Blades

The hazard of a broken bandsaw blade whipping around is said to have been completely eliminated in the high-speed bandsaws offered by the Tannewitz Works, Grand Rapids, Mich., in which two hydraulic brakes automatically bring both wheels to a stop the instant a break occurs.

Brakes are automatically applied when current is shut off. This occurs in the case of saw blade breakage by means of a saw tension lever which snaps back the instant the saw breaks, pressing the button which automatically shuts off the current and applies the brakes. A further advantage of this feature is that both wheels may be stopped instantly without throwing undue strain on the saw blade.

Two New Series of Drawing Machines Offered by Drafto

The Drafto Co., Cochranton, Pa., has placed on the market two new series



of drawing machines. Of the portable type, there are seven new models in the series.

The three models in the 30 series have specifications as follows: No. 30H-6-8, which takes 12x18-in. sheets and is sold complete with 6 and 8 in. detachable scales; No. 30V-6-8, which is a vertical type, but in other respects identical with the model above; the No. 30U-6-8, which is sold unmounted, but which is otherwise identical with the Model 30H-6-8.

The four models in the 35 series have the following specifications: No. 35H-8-10, which takes 15x20-in. sheets of drawing paper and is sold complete with 8 and 10 in. detachable scales; the No. 35U-8-10, which is sold unmounted, but is otherwise identical with the model above; the No. 35C-8-12, which takes 18x24-in. sheets of paper and is sold mounted on a 23x31-in. seasoned wood board, complete with 8 and 12 in. detachable scales; the No. 35CU-8-12, which is sold unmounted but with a mounting bracket, and complete with 8 and 12 in. detachable scales.

In both these series the protractor is made of stainless steel with all graduations machine cut. A vernier permits setting the machine to ½ deg. Boards, except that on the Model No. 35C-8-12, are of green masonite. Arms are made of chrome steel with a bright chrome finish on top and a dull chrome on the bottom. All other parts are finished in dull chrome. Finish on the protractor is a circular polish making it easy to read. A latch makes it possible to lock the protractor accurately at 0, 30, 45, 60 and 90 deg. on either side of the zero mark.

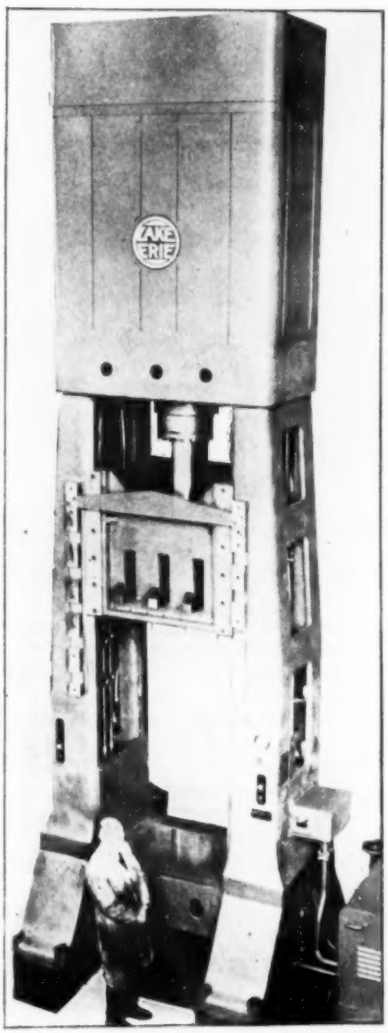
Fluorescent Lamp Developed For Low Bay Industrial Areas

An open-end twin-lamp fluorescent luminaire, utilizing 40-watt, 48-in. Mazda Type F white or daylight lamps and offered by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been designed especially for general or supplementary lighting of low bay industrial areas. This unit, the Type FPR, is available only in the spread distribution style for operation on 110–125, 199–216, and 220–250 volts, 60 cycles a.c.

Luminaire consists of a hood, reflector, lamp holders, starting device, and ballast equipment. Hood is of fabricated sheet steel and carries the hinged porcelain enameled steel reflector which provides high over-all efficiency with a light cut-off of 72½ deg. from the vertical. Lamp starter is completely self contained in an aluminum housing which plugs into a socket located in the fixture hood; thus it may be replaced for maintenance as easily as lamps themselves. Two-lamp ballast with starting compensator is used to provide a power factor of 95–99 per cent.

150-Ton Hydraulic Press Draws Cartridge Cases

An unusually long stroke 150-ton hydraulic press built by Lake Erie Engineering Corp., 268 Perry St., Buffalo, N. Y., has been especially designed for drawing cartridge cases. Having 108 in. daylight and a stroke of 76 in., this press has a solid housing with a gib-guided platen. Adjustable knock-out bars are provided for other types of work, thus making it convertible to an all-purpose press.



Conveniently located pushbuttons control inching, semi-automatic and full automatic operation. Adjustable control of working pressure and stroke contribute flexibility to suit various operations, and save die setting time. Top of the press is completely inclosed in removable panels. A high-speed pumping unit provides fast approach and return of the moving platen.

Protection to Welders Afforded by "Ply" Cream

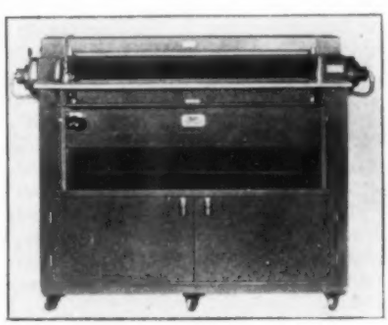
Protection to welders and cutters, especially when large diameter rods are being used, with resultant flashes, is given by "Ply" No. 8, a vanishing cream offered by Milburn Co., 905 Henry St., Detroit, Mich. Use of this cream make it possible for welders and cutters to work scantily clad, for comfort during hot weather, without danger of burning from the ultra-violet and infrad-red rays.

Ply No. 8 is applied like a vanishing cream, rubbing into the skin completely dry and practically invisible. Its ingredients form an effective block to the rays to prevent burning.

Ozalid Whiteprint Machine Comprises Compact Unit

A fast-printing whiteprint machine developed by the Ozalid Corp., Johnson City, N. Y., has been built to serve a market for which printers equipped with low-pressure mercury vapor lamps are too small and high-speed reproduction machines are too expensive. In the Ozalid Model F, the printer and dry-developer are combined in one compact light-weight unit which can be easily installed in any print room or drafting room. This machine includes all facilities necessary to produce finished dry-developed whiteprints in less than two minutes. Yet it requires less than 14 sq.ft. of floor space and is claimed to use less than one-half as much electrical energy as other types of printers having equal capacity.

A new high-pressure mercury vapor lamp with an output of 40 watts per inch and an active length of 46 in. gives printing speeds ranging up to 56 in. per min. Original and sensitized materials are held in contact with a 4¼ in. glass cylinder which



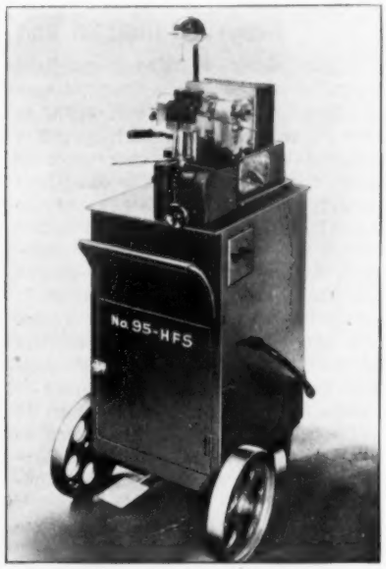
revolves around the stationary lamp. An adjustable light shade permits the operator to vary exposure without changing the printing speed. Cooling of the lamp is provided by a two-stage blower.

Machine is driven by a resiliently mounted split phase ¼ hp. motor. The developer is driven by the motor through a specially designed 50: 1 reduction gear, and the printer through a friction disk type variable speed transmission, providing printing speeds of from 4 to 56 in. per min.

Portable Butt Welder Handles Stranded Wire

Eisler Engineering Co., 740 S. 13th St., Newark, N. J., has developed a portable butt welder with a burr grinder and annealer mounted on a fabricated case which is especially suitable in the repair of stranded wire. By fusing all the strands, the ends are prevented from unraveling. Final steps are then to butt weld the two ends and to grind off any burrs that may have appeared during the operation.

Grinder has an accurate adjustment to compensate for abrasive wear. There are two special bush-



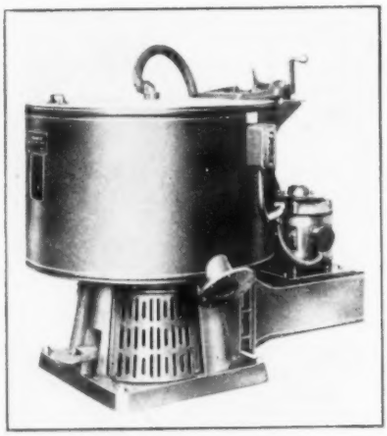
ings to guide the stranded wire to the grinder which squares off the ends in order to make neater welds. All wiring has been concealed within the fabricated case, and a draft tube has been provided to remove grinding dust.

Machine is supplied with a 3-kva. air-cooled transformer and an 8-point variable switch for current regulation. Unit is foot operated, and butt jaws can be water-cooled for continuous service. Metal from $\frac{1}{16}$ to $\frac{3}{16}$ in. in diameter can be welded. For butt welding other sizes, units are available with transformers ranging from 1 to 7½ kva. capacity.

Tolhurst "Centriforce" Washer Cleans Small Metal Parts

A centrifugal which washes, rinses and dries small metal parts in one machine has been announced by Tolhurst Centrifugal Div., American Machine & Metals, Inc., East Moline, Ill. Known as the "Centriforce" washer, this unit is designed for use in machine shops and plating plants.

As a detergent washer, the machine washes screw machine parts with hot detergent solution to remove oil, grease, dirt or fine chips. As a rinser, the work is spun in the centrifugal while a spray of hot water

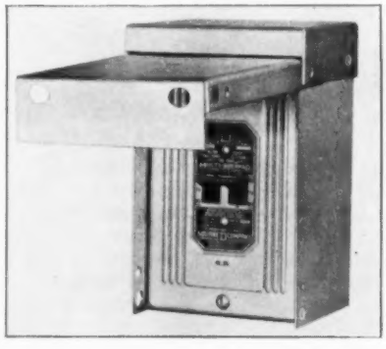


swirls through the parts. As a dryer (use of sawdust is eliminated), the machine is revolved at high speeds while blasts of hot air are forced through and around the parts. Up to 25 batches an hour are handled in the unit.

Raintight Inclosures Developed For Type MO "Multi-breakeR"

The Square D Co., Detroit, Mich., has developed a raintight inclosure for the 25-amp. frame Type MO "Multi-breakeR." This inclosure is a galvannealed steel hood which can be used to inclose any standard surface Type MO unit.

Cover is removable for easy wiring. Outside dimensions are 7 in. high, 4½ in. wide and 3⅞ in. deep. Provision is made for padlocking the cover.



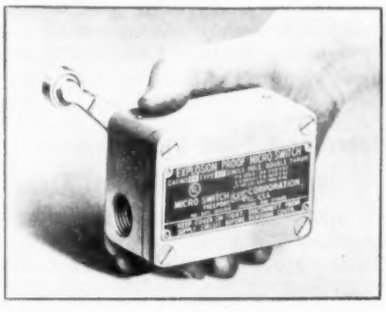
Flat Top Die Trucks Feature Welded Construction

Two new types of flat top die trucks have been announced by O. Johnson Mfg. Co., Dept. K, 6027 W. Roosevelt Rd., Cicero, Ill. Of rigid electric-welded construction, these trucks are made for long and useful service.

The simplicity and ease of operation of these units is claimed to make them particularly valuable for transferring and supporting dies. They are equipped with rubber cushioned heavy duty ball bearing casters for easy handling. The No. F-1 truck has a 28x40-in. table and a capacity of 3,000 lb. The No. F-2 has a 24x32-in. table and a capacity of 2,000 lb. Both provide an adjustable table height of from 24 to 40 in.

Micro Switch Housing Is Explosion Proof

An unusually compact housing for the Micro Switch element has been developed by Micro Switch Corp., Freeport, Ill., especially for use in explosive atmospheres. Measuring only 3⅝x2½x2 in., this explosion-proof housing is listed by the Underwriters' Laboratories for hazardous locations of Class I, Groups C and D, and Class II, Group G. These groups include atmospheres containing vapors of ethyl ether, gasoline, alcohol, ace-



tone, lacquer solvents, etc., and grain dusts.

Types of actuation available with this housing are roller arm with roller axis either parallel or at right angles to the arm, and a bullet nose push rod type. All types have precision characteristics with a maximum movement differential of 0.001 in. Mounting space is kept at a mini-

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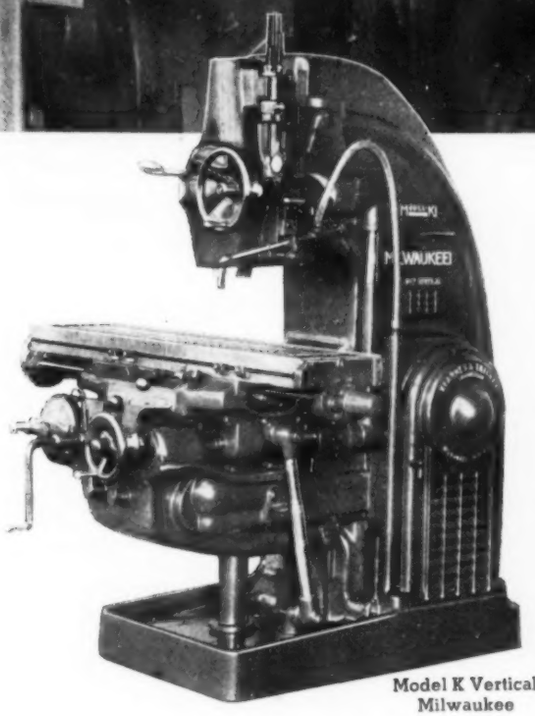


Model K Vertical
Milwaukee

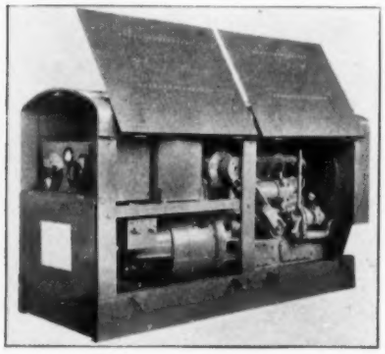
Milwaukee MILLING MACHINES

mum by omitting feet and lugs and providing a pair of tapped holes on each of the four sides. Removable cover plate provides access to terminals supported on the switch element itself. This element is the standard Micro Switch having a rating of 1,200 watts at up to 600 volts a.c.

Lincoln 400-Amp. Diesel Welder Has Gasoline Engine Starting

Application of gasoline engine starting to its line of diesel driven arc welders has been extended to include the 400-amp. model built by Lincoln Electric Co., 12818 Coit Rd., Cleveland, Ohio. This advance makes available easy starting in any weather and permits inherent economies of diesel drive in the various applications for engine driven welders in the larger capacities.

Gasoline starting is effected by a

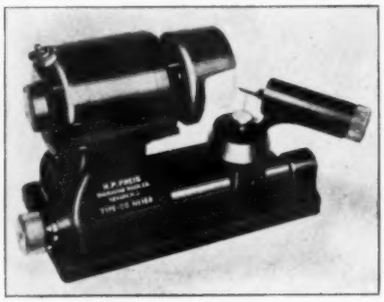


small auxiliary engine mounted above the diesel, which is started by means of a hand crank. A belt drive, engaged by means of a clutch, connects the starting engine to the diesel. Starting in extremely cold weather is facilitated by having the cooling system of the small starting engine connected with that of the diesel. This permits warming up the diesel by running the starting engine a short time and allowing the heated water to circulate through the diesel jacket.

Small Bench Grinder Sharpens Single Lip Routing Cutters

A compact bench-type grinder for accurate sharpening of single-lip engraving and routing cutters has been developed by H. P. Preis Engraving Machine Co., 157 Summit St., Newark, N. J. This machine, known as "Panto" Model CG, handles tapered-shank cutters and straight-shank cutters up to ¼ in. in diameter.

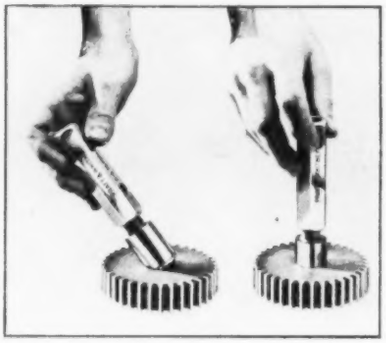
Grinding wheel is of the cup type, 2¼ in. in diameter, and is attached directly to the shaft of a totally inclosed ball bearing universal motor operating at 8,500 r.p.m. Cutter-holding spindle is mounted in a swivel arm which is graduated for quick setting to any cutting angle or taper. Stop notches are provided for grinding three-cornered or four-cornered cutters. While the cutter is rotated with the operator's right hand, the carriage is fed to the grinding wheel by means of a feed screw actuated with the left hand.



Unit is 9½ in. long, 4½ in. wide, and 6 in. high. Weight is 13 lb. A solid spindle is furnished for users of tapered-shank cutters only, and a collet spindle is available for those using both tapered-shank and straight-shank types.

P&W "Pilot" Plug Gage Enters Holes Easily

Pratt & Whitney Div. of Niles-Bement-Pond Co., West Hartford, Conn., has made available a line of "Pilot" plug gages which are easily inserted in holes. Instead of being difficult to

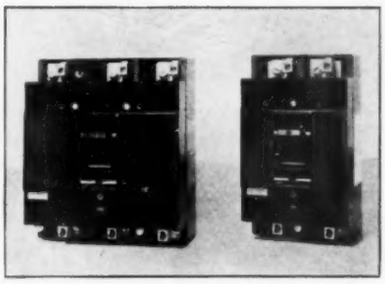


start, this plug gage can be presented lightly at an angle and almost falls in by itself. The combination of a chamfer at the end and the angular groove near the end permits easy entry, and the gage centralizes itself, lines up and enters without jamming. Even when the plug is a very close fit it slides in without difficulty.

In addition to the time saved by speeding up the actual gaging operation, the "Pilot" saves additional time since it will not jam, thereby causing possible damage both to the work and to itself.

General Purpose Circuit Breakers Have Adjustable Trip Setting

A line of Type AB general utility circuit breakers for inclosure, panelboard or switchboard mounting featuring an adjustable trip setting has



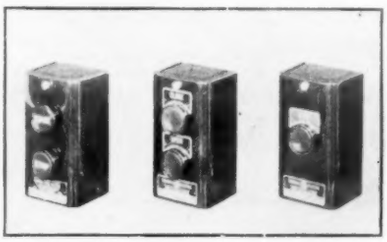
been made available by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. These breakers, rated at 50, 70, 90 and 100 amp. at 250 and 600 volts a.c., 2 and 3 pole, and at 125 and 250 volts d.c., are especially adaptable to lighting and feeder circuits and to motor branch circuit protection.

All breakers use the 100-amp. frame, permitting physical interchangeability. The adjustable magnetic trip permits very close setting of the breaker for any tripping current from 3½ to 11 times the breaker's normal rated current, and enables the trip to be set in the field under actual service conditions to give maximum protection to the equipment. An inverse time thermal trip of the bi-metallic type provides adequate protection for light overloads. Improvements over the older series include use of a hot molded base and cover, a replaceable molded operating handle, and an external trip rating marker located in plain view on the breaker cover. The moving contact arm has also been redesigned to require minimum flexing of the shunt, insuring longer life.

Standard Duty Pushbutton Stations Announced by General Electric

A line of general purpose one and two button standard duty pushbutton stations announced by General Electric Co., Schenectady, N. Y., offers improvements in operation, appearance, and ease of installation. Having ⅞ in. molded buttons, they are similar in appearance to the G.E. heavy duty stations.

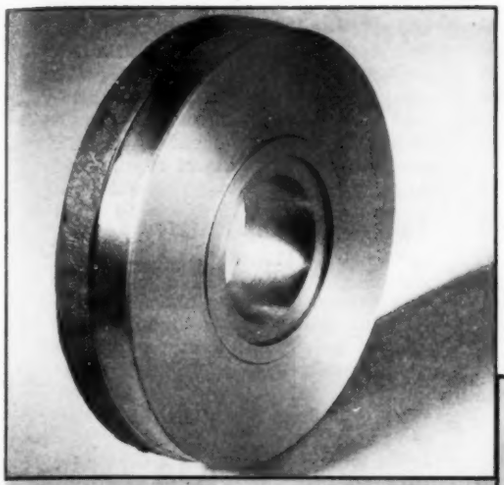
Buttons are protected from acci-

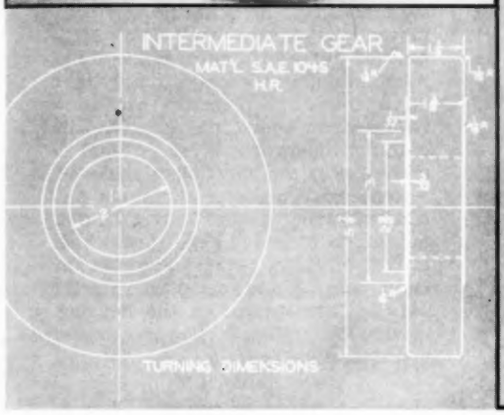


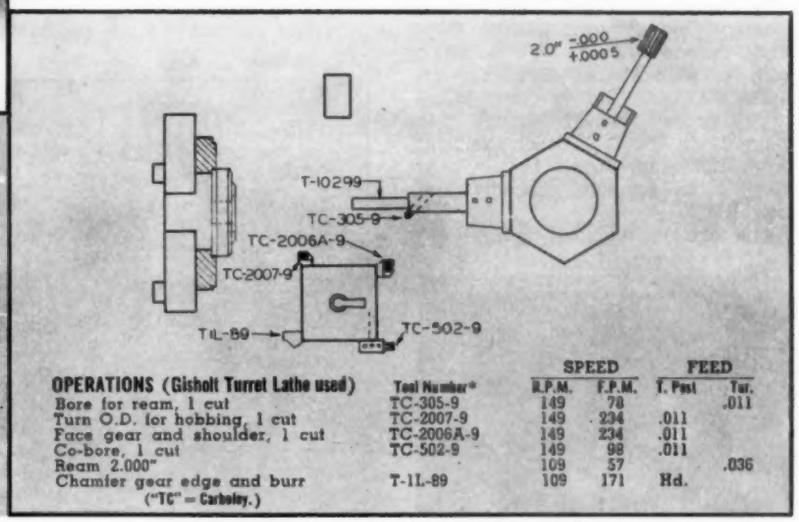
dental operation by guard rings. The words "Start" and "Stop" molded into the buttons are filled with white paint to make them easily readable. Further identification can be provided on separate plates attached to the inclosure above the buttons.

Inclosures measure 4 $\frac{9}{16}$ in. high,

How To Cut Steel with CARBIDE TOOLS







OPERATIONS (Gisholt Turret Lathe used)	Tool Number*	SPEED R.P.M.	SPEED F.P.M.	FEED T. Post	FEED Tur.
Bore for ream, 1 cut	TC-305-9	149	78		.011
Turn O.D. for hobbing, 1 cut	TC-2007-9	149	234	.011	
Face gear and shoulder, 1 cut	TC-2006A-9	149	234	.011	
Co-bore, 1 cut	TC-502-9	149	98	.011	
Ream 2.000"		109	57		.036
Chamfer gear edge and burr	T-1L-89	109	171	Hd.	

("TC" = Carboloy.)

One of more than 1000 Carboloy tool applications at Gisholt Machine Co.—80% of which are steel cutting.

Production men now preparing for the large production increase to come when the full force of the defense program reaches industry, will find much information of *IMMEDIATE* value in the NEW engineering bulletin, "Machining Steel with Carboloy Tools."

It describes how to provide best machine conditions for machining steel with carbides, gives you recommended tool rakes; most efficient chip breakers and a simple way to duplicate them. Helps you to select correct speeds and feeds for all types of steel. Describes use of coolants, and takes the "guess-work" out of carbide grade selection.

This new bulletin GT-123 will be sent to you free upon request.

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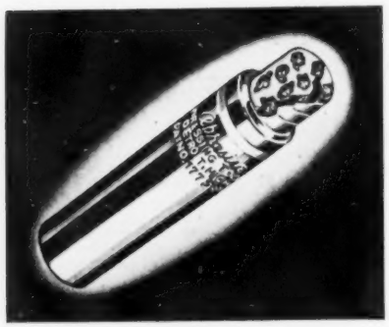
TANTALUM CARBIDES
TITANIUM CARBIDES
TUNGSTEN CARBIDES

2⅝ in. wide, and 2½ in. deep. They are made entirely of steel, consisting of a back and cover. Cover is crimped over at the ends to overlap the top and bottom ends of the back, and is held in place by screws at top and bottom. Mounting holes are conveniently located.

Improved Diamond Tools Offered by Abrasive

Abrasive Dressing Tool Co., 1550 Broadway, Detroit, Mich., has begun production of an improved line of diamond tools known as the "Red Band" series, positively identified with a brilliant red band on the shank. In addition to the "Oxide-Free" process which secures the diamond in the tool, other exclusive production methods have been adopted to promote economy and long life.

The No. 11 diamond tool is de-



signed for versatility. It contains three rows of diamonds, precisely staggered and spaced to permit the tools to be used for single-stone dressing, or for cluster-type dressing. By regulating the drag-angle, a single stone or three stones may make contact with the wheel. It contains 11 diamonds, weighing approximately 1.25 karats.

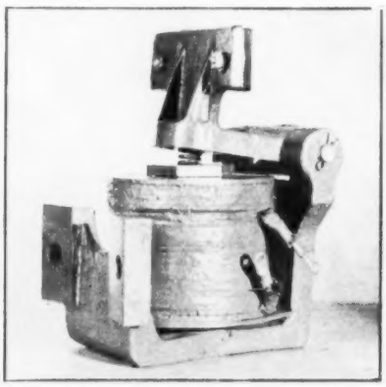
Cowles Aluminum Cleaner Developed to Prevent Corrosion

A general cleaner for aluminum parts of all kinds has been added to the line of metal cleaners manufactured by Cowles Detergent Co., 7016 Euclid Ave., Cleveland, Ohio. Identified as Cowles AE, this mildly alkaline cleaner has been especially developed to prevent corrosion of nonferrous metals.

Mirror-finished surfaces of aluminum are said not to be visibly affected by an hour's exposure to concentrations of this cleaner as high as six ounces per gallon at boiling. AE cleaner has been compounded to produce in solution the high colloidal activity and proper balance of detergent anions necessary for the efficient and safe cleaning of aluminum parts from accumulations of shop dirt and drawing and cutting oils. It is customarily used in concentrations of three to six ounces per gallon of hot water. Parts rinse freely and after drying are ready for further finishing or assembly.

Magnetic Brake Holds Gearless Cable Reels

A magnetic brake for use on open type vertical axis gearless cable reels to prevent the cable from unwinding due to power failure has been made available by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Brake is rigidly mounted on the reel motor

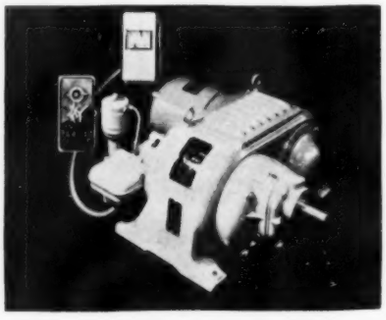


frame in such position that the brake shoe contour is adjacent to the inside of the reel drum. As long as power is applied to the reel, a magnetic holding coil in the brake holds the shoe away from the drum. When power fails, the coil is de-energized and the brake shoe is projected, by means of a spring, against the drum. This immediate stopping prevents the cable from unwinding and snarling.

Electric Remote Control Available for "Varidrives"

U. S. Electrical Motors, Inc., Dept. 23, 80 34th St., Brooklyn, N. Y., has developed a system of electric remote control for the U.S. "Varidrive" motor. This system makes possible automatic control of the take-off shaft speed by means of a thermostat, float switch or other control.

The control consists of a small worm gear reducer mounted on the "Varidrive" control case and connected to the control shaft which



changes the speed. The pilot motor is operated by a thermostat, float switch or similar control through a cyclic relay or process timer. The thermostat or float switch controls the direction of speed change, while the cyclic relay governs the rate of change.

Guth Fluorescent Fixtures Make Maintenance Easy

A fluorescent lighting fixture developed to provide better maintenance as well as efficient light control has been made available by the Edwin F. Guth Co., 2615 Washington Ave., St. Louis, Mo. Known as the Utility "Flu-O-Flector," this unit provides a separate inner reflector and a protective steel housing, the reflector being removed by unscrewing two large knurled nuts. With extra reflectors at hand, maintenance crews simply take down the dirty reflectors and substitute clean ones. Time is saved, the cleaning operation is safer, and a much better cleaning job is achieved.

Reflector is made of aluminum finished by the Alzak process. Outer housing is of heavy gage steel which is rust-protected. High power factor lamp control and accessible starter switches are secured in the housing, leaving the reflector free for better maintenance.

NEW MATERIALS

Jessop Free Machining Steel Has Non-Magnetic Properties

A non-magnetic free machining alloy steel possessing low magnetic permeability with superior mechanical properties has been developed especially for the electrical industry by Jessop Steel Co., 595 Green St., Washington, Pa. Another desirable property of this steel is its high electrical resistance, which considerably reduces eddy current losses.

Shown in the illustration is a piece

of electrically magnetized iron at the right and a piece of Jessop non-magnetic steel at the left. Note that the lines of force (shown in iron filings) are all directed to the iron sample at the right. In the annealed condition, this steel has a tensile strength

of 80,000 to 110,000 lb. per sq. in., a yield point of 35,000 to 60,000 lb. per sq. in., 2-in. elongation of 25–50 per cent, reduction of area of 30–60 per cent, and Izod impact value at room temperature of 80 ft.-lb.

It is claimed that this non-magnetic steel can readily be formed, welded, machined and blanked. It can be used in transformer controller switch covers, entrance plates, spacing bars and fingers, and numerous other parts of electrical equipment.

Practical Molds for Plastics

An interchange of illustrations in the article "Practical Molds for Plastics" (*AM*—Vol. 84, page 489) has been called to our attention by Mr. Lehmann, author of the article. The drawing shown on page 489 should appear with the caption for Fig. 3 on page 490, while the illustration now shown with this caption should be shown on page 489 with the caption for Fig. 1.

TRADE PUBLICATIONS

ACCESSORIES The Allen Manufacturing Co., Hartford, Conn. has just published a listing of die makers' accessories in Pamphlet 119.

ALLOY STEEL Jessop Steel Co., Washington, Pa. discusses in an 8-page folder the applications of "Truform" oil-hardening, non-shrinkable alloy tool steels.

ARC WELDING ELECTRODES Booklet No. ADW-18 issued by Wilson Welder & Metal Co., Inc., 60 E. 42nd St., New York, N. Y., contains 24 pages illustrating arc welding electrodes.

BEARINGS A 76-page catalog No. 400 circulated by Johnson Bronze Co., New Castle, Pa., offers a progressive size listing of bearings.

BEARINGS The Bunting Brass & Bronze Co., Toledo, Ohio, has issued a general catalog of bearings available from stock.

BEARINGS A 112-page booklet discussing the factors to be considered in the selection of anti-friction bearings is offered by New Departure, Division General Motors Corp., Bristol, Conn.

CARBON TOOL STEELS Allegheny Ludlum Steel Corp., Pittsburgh, Pa. has just published a folder on the subject of Straight Carbon Tool Steels.

CENTRIFUGALS Three booklets have been issued by the Tolhurst Centrifugal Div. of the American Machine & Metals, Inc., 100 Sixth

Advertisement

New Alloy Steel Has Longer Life For Heavy Duty Applications

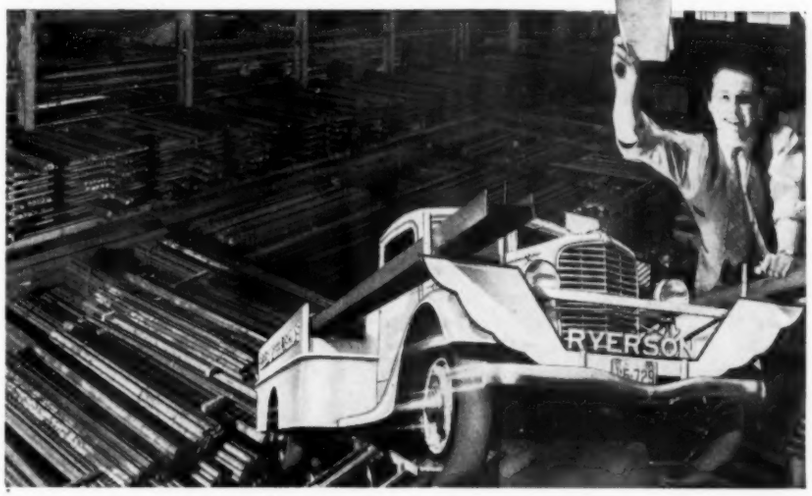
Many machine shops report favorable results with S.A.E. 4815—a carburizing nickel-molybdenum alloy steel for heavy duty gear and shafting applications.

An outstanding advantage of S.A.E. 4815 is the high core strength which may be developed by the single quench treatment. In sections up to 1" tensile values up to 200,000 p.s.i. and yield strengths in the neighborhood of 165,000 p.s.i. may be developed in the core together with hardnesses up to 415 B.H.N., providing excellent backing for the case under crushing loads. The tough, fine-grained case which is readily developed provides exceptional resistance to wear, spalling and pitting fatigue—making S.A.E. 4815 exceptionally well suited for highly stressed parts, such as gears, pinions, spindles, splined transmission shafts and pins.

In its normalized condition, cutting speeds and finish compare with S.A.E. 4615 and S.A.E. 2315.

S.A.E. 4815 is carried in stock by Joseph T. Ryerson & Son, Inc., in hot rolled rounds in diameters ranging from ¼" to 6" inclusive. For further information, write the nearest Ryerson plant (see advertisement below).

Steel for Defense . . .



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Bars, plates, sheets, shapes, beams . . . stainless steels and alloys . . . 10,000 different kinds, sizes and shapes . . . all in stock for instant service! And all Ryerson Certified quality, your positive insurance against shop losses due to faulty steel. Ryerson Certified Steels are closely controlled as to chemical content, accuracy and finish, without the slightest increase in cost to you.

If you don't know Ryerson reliability, and if you're working on defense orders or other RUSH business, and you need steel, "Get in touch with Ryerson today!"

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SPEED UP YOUR WELDING OF HIGH STRENGTH—LOW ALLOYS WITH

MUREX

ELECTRODES

SPECIALLY DESIGNED FOR CARBON-MOLY, COR-TEN, MAYARI, CROMANSIL, 2%-3% NICKEL AND OTHER STEELS

The Murex line includes a group of specially developed rods designed to produce welds with tensile strengths ranging from 70,000 to 100,000 lbs. per sq. in.; ductilities of 20% to 30% and corrosion and heat resisting qualities matching closely any of the more widely used new steels. Because of their excellent deposition rates at high amperages, their ease of handling by skilled welders, and the assurance they provide of cleaner, smoother deposits they step up welding speeds and help hold down costs.

Ask to have Murex Electrodes demonstrated on your high strength—low alloy applications. A note to the nearest M & T office will bring a representative promptly.

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Investigate Thermit Welding, too—in use since 1902 for heavy repair work, crankshafts, housings, frames, etc.

Ave., New York, N. Y. which describe the application of centrifugal force to the drying, enameling and galvanizing of metal products.

DOUBLE STRENGTH STEEL A 40-page illustrated catalog No. 353 circulated by Republic Steel Corp., Cleveland, Ohio, discusses the development and application of double-strength steel.

DUST CONTROL Bulletin No. 270 circulated by American Air Filter Co., Inc., Louisville, Ky. provides information regarding "Roto-clone" dust control.

DYNAMOMETERS A 4-page illustrated folder No. GEA-2924 describing inductor type dynamometers is being circulated by General Electric, Schenectady, N. Y.

ELECTRODES A 12-page illustrated booklet No. 26–645 offered by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., describes a.c. and d.c. "Crucible-Weld" Flexarc welding electrodes.

END MILLS A 4-page pamphlet, No. 109, issued by Goddard & Goddard Co., Inc., Detroit, Mich., illustrates the construction and operation of "Spi-Rate" end mills.

GEAR CHECKING National Broach & Machine Co., Shoemaker and St. Jean, Detroit, Mich. has published an eight-page pamphlet which discusses the testing of gears for noise.

GEARED DRIVES A 34-page illustrated booklet, issued by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., describes the features of geared drives.

GEARS Brad Foote Gear Works, 1301 So. Cicero Ave., Cicero, Ill. notes prices of all sizes of stock gears in its 1940 Catalog No. 110.

GRINDING "The Use of Abrasives for Removing and Finishing Metals" is the title of a four-page bulletin, Form No. G-455, recently published by Cincinnati Milling Machine and Cincinnati Grinders, Inc., Cincinnati, Ohio. This bulletin was prepared by George Binns and discusses the factors affecting grinding operations on various types of machines. The bulletin should be interesting and helpful to those executives in charge of grinding machine operators and apprentices.

LEATHER LINK BELTS Booklet No. A-13 circulated by Alexander Bros., 406 North Third St., Philadelphia, Pa. illustrates the application of duplex leather link belts.

LEATHER PACKINGS A 20-page catalog issued by E. F. Houghton & Co., Third, American and Somerset Sts., Philadelphia, Pa. discusses the application of leather packings.

MATERIALS HANDLING Catalog No. 21 circulated by Lewis-Shepard Sales Corp., 295 Walnut St., Watertown, Mass., describes 175 items of their line of materials handling equipment.

PLANER DRIVES An 8-page booklet No. B-2214 circulated by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., describes variable voltage planer drives.

POWER SQUARING SHEARS Niagara Machine & Tool Works, 637–697 Northland Ave., Buffalo, N. Y. illustrates and discusses power squaring shears in 23-page bulletin No. 72-A.

PRESS BRAKES The Cincinnati Shaper Co., Cincinnati, Ohio, describes the construction design and operation of press brakes in a new bulletin.

RELAY Leaflet No. GEA-2902B circulated by General Electric Co., Schenectady, N. Y. offers illustrated information regarding a vacuum-tube timer.

RESINS A booklet which describes the fabrication of resins by common woodworking and metal working methods, has just been issued by Union Carbide & Carbon Corp., 30 E. 42nd St., New York, N. Y.

ROLL GRINDERS A 12-page booklet circulated by Mesta Machine Co., Pittsburgh, Pa., describes the construction and performance of roll grinders.

SAFETY SWITCHES Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., describes in leaflet No. 29–550 its safety switches for industrial and general purpose application.

SHAPERS Illustrated catalog No. 1 offered by the Cincinnati Shaper Co., Cincinnati, Ohio, describes their rapid traverse high speed shapers.

SMALL TOOLS Catalog No. 8 circulated by the Weldon Tool Co., Cleveland, Ohio, contains a 73-page listing of all its stock tools.

SPRAY GUNS A four-page folder circulated by Master Metal Spray, Inc., 2527 Magnolia St., Oakland, Calif., discusses the operation of metal spray guns and moisture separators.

SPRAY PAINTING EQUIPMENT The DeVilbiss Co., Toledo, Ohio, has just published a handbook titled, "The A.B.C. of Spray Painting Equipment."

TUBE EQUIPMENT Bulletin No. 40E issued by The Parker Appliance Co., 17325 Euclid Ave., Cleveland, Ohio, contains instructions and a price list concerning tube bending equipment.

TURRET LATHES Circulated by Gisholt Machine Co., Madison, Wis., is a new 40-page booklet which describes standard tools for turret lathes.

V-BELT DRIVES A new V-belt guide, form No. 325, has been issued by L. H. Gilmer Co., Tacony, Philadelphia, Pa.

WELDING ACCESSORIES Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh, Pa., illustrates a new one-piece model welding helmet and accessories in a four-page folder.

NEW BOOKS

PRINCIPLES OF MECHANISM, *Third Edition—By F. Dyson, lecturer in mechanical engineering, City and Guild (Engineering) College, Imperial College of Science and Technology, London. 363 pages. Oxford University Press, 114 Fifth Ave., New York, $4.25.*

The theory of machines rather than the practical application of machine design is the object of this volume. While it is recognized that the student and the graduate engineer often find gaps between theoretical concepts and the technique of putting them into practice, this ground has been thoroughly covered by many volumes on machine design.

The third edition follows the same general arrangement as those which preceded it, but has two new sections on advanced work. New material includes data on planetary gearing, pre-selective gear boxes, acceleration of a piston, mathematical analysis of a follower in contact with a cam face and acceleration diagram for a quick return motion.

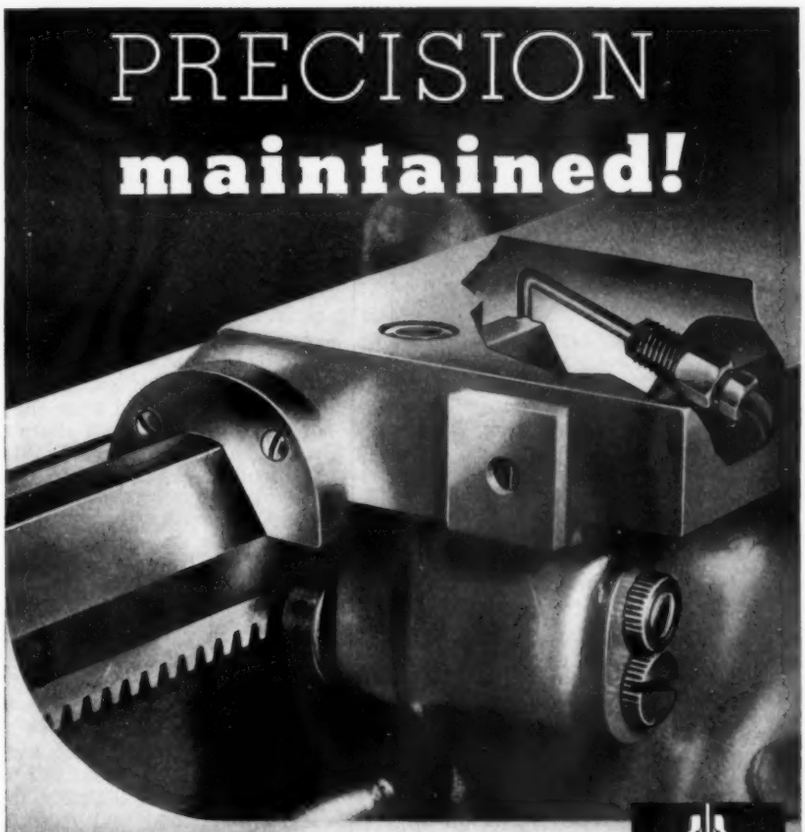
Examples are provided for practically all the points covered.

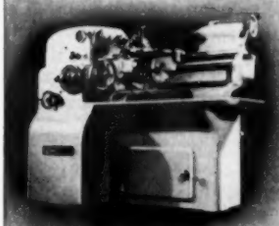
•

FABRICATION OF U. S. S. STAINLESS STEELS—*Prepared by United States Steel Corporation Subsidiaries. 92 pages. Published by Carnegie-Illinois Steel Corp., Pittsburgh, Pa. $1.*

This practical book, which discusses the welding, riveting, soldering, machining, cutting, forming, annealing, pickling, surface finishing and protection of the various U.S.S. stainless steels, is divided into three comprehensive sections. The technical and practical aspects of stainless steel fabrications are discussed in detail. Austenetic, ferritic and martensitic stainless steels are treated separately and in detail.

Part I is devoted to welding, riveting, soldering and joint design, and includes a series of diagrams illustrating the various joints commonly used in fabricating stainless steel. The application of these joints are discussed in detail and their efficient use is described. Part II takes up machining, cutting, forming, anneal-

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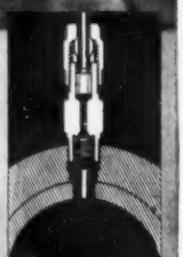
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Service Die & Engineering Company, Detroit, made this complete die on the DoAll. It is used to make the glove compartment on the instrument panel of a well-known automobile.

DIE—2¼" thick mild steel was sawed out in 1¾ hours.

PAD—1½" thick air die steel, sawed out in 2½ hours. 25 pounds of steel were saved.

STRIPPER—¾" cold roll, sawed out in 45 minutes.

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CAM DRIVES—on the DoAll table—2½" oil hardened tool steel, sawed out in 20 minutes each. Later they were welded to base.

Two DoAll Contour Machines and one DoAll Band Filer are kept busy 24 hours a day in this modern plant.

The DoAll is a moderately priced, rugged machine tool that replaces shaping, milling and lathe work with enormous savings of time, labor and metal.

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ing and pickling operations. Recommendations as to equipment, temperatures, solutions, etc., are presented. Surface finishing and protection are discussed in Part III. Standard mill finishes are described and the operations and equipment involved in developing desired finishes are covered in detail. Laboratory corrosion data covering a wide range of chemicals and acids are presented for four types of stainless steels and the chemical, physical and mechanical properties, with notations as to abrasion resistance, cold forming and welding, are tabulated for nine types of stainless steels. Copies of this book may be secured from the offices of the Carnegie-Illinois Steel Corporation, American Steel & Wire Co., Columbia Steel Co. or the National Tube Co.

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PRODUCTION MANAGEMENT—*Written by A. M. Simons and reviewed by Henry Post Dutton. 588 pages. Published by American Technical Society, Chicago, Ill. $3.50.*

Production problems today are so complex and demands upon management are so varied that successful industry must employ the highest grade of professional ability. The profession of industrial management rapidly is being filled by men who have supplemented personal experience with organized education. This book has been prepared to aid the student of industrial management in solving production problems.

Written primarily for the student, and not too technical in its language, this volume covers practically all of the phases of production management in easily understood language.

•

MACHINE DESIGN DRAWING ROOM PROBLEMS—*By C. D. Albert, Professor of Machine Design, Cornell University. 441 pages. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. $3.50.*

In this third edition of "Machine Design Drawing Room Problems" five of the seven design problems of the second edition have been retained and revised, the three reference chapters of the second edition have been expanded to six chapters and almost entirely rewritten, and eight new problems and four new reference chapters have been added. The arrangement of the chapters also has been changed. The first fourteen chapters consist of an introductory chapter followed by thirteen chapters, each of which is devoted to a design problem. The last nine chapters are reference chapters so arranged that the major part of the information in tabular form is in the last two chapters of the book. The design problems are arranged practically in the order of their length and the time required for their solution. The notation has been changed throughout to agree with that used in the more recent books on mechanics and strength of materials, and also to agree, so far as possible, with the recommendations of the American Standards Association.

Full use of drawings and photographs is made throughout the text, with tabulated data being used wherever necessary. Each problem deals with a specific piece of apparatus in common use and is designed to bring out certain specific factors in machine design. The author presupposes a knowledge of kinematics, mechanics and engineering drawing and offers in this book complete material for a drawing room course in general machine design. The author assumes that a separate recitation course is to be given based upon some standard text on general machine design.

•

INDUCTION MOTORS—*By S. Gordon Monk, head of Electrical Engineering Department, Plymouth and Davenport Technical College. 146 pages. Distributed by The Chemical Publishing Co., Inc., 148 Lafayette St., New York, N. Y. $2.*

Published in England, this cloth-bound volume, according to the author, is intended as a general survey of the properties and applications of induction motors. It is not intended to be exhaustive, and the design part of the subject has only been lightly touched upon. The fundamental principles and properties of induction motors have been the main concern of the author. Examples for student use are given at the end of each chapter. Answers to these examples are listed in the back of the book.

TO THE EDITOR

Why Not Summer-School Training?

Dear Sir:

Your editorial, "Bewildered, Not Lost!", interests me very much, and has led to the following comments:

Granted that it takes some years to make a skilled craftsman, nevertheless it has been demonstrated that high-school graduates, carefully chosen for intelligence and mechanical aptitude, can be taught in a short time to perform efficiently many types of work in the skilled classifications, if they are given adequate instructions at each step, followed by close and continued supervision.

In many of our industrial centers, the public vocational high schools close their doors about the first of June, leaving idle for three months equipment worth hundreds of dollars. Is there any good reason why industry could not select and send young men to these institutions for an in-

tensive course of instruction during this three-mouth period? Cannot promising young men with some experience be sent to these schools at night to further their knowledge, skill and experience?

True, the number trained in this manner would be small; but at least we would have a few more workers who had been properly trained in the operation of machine tools, and a few more who had a start toward the higher skills. Here at least is a potential source which should be investigated, and it is time the fields of industry and education were brought closer together.

Another thought: In many plants there may be equipment in the tool room or maintenance departments which is not being used 24 hours a day. Is there any good reason why at least some of this equipment could not be used for training during the second or even third shift?

This, of course, brings up the problem of obtaining instructors; but if this problem is analyzed we find that by selecting the right men, a short course in training would teach them the fundamentals of imparting their knowledge to the other fellow.

The success of such programs would depend on three points: first, the selection of the young men; second, enough instructors to provide adequate instruction followed by continuous supervision; third, work produced, tools used and working conditions should approach as near as possible the actual conditions found in industry.

Quite naturally production is one of the first thoughts of management; but production depends on workers, and perhaps management needs to give first place, for the moment, to training future skilled craftsmen.

It is a tough problem, but it can be licked if enough thought is given to the job now, before we find a real emergency on our hands.

Yours very truly,
CARROLL JOHN GROOM
Director Vocational Training
The Hoover Company
North Canton, Ohio

The Pen Is Mightier . . .

Dear Sir:

Your editorials are as important as the excellent data inclosed and as the fine, modern equipment you advertise. The coordination of the machine to meet our human needs is worthy of substantiation. Your editorials can do this.

I want you to know my father was a reader of AMERICAN MACHINIST when it was just a twinkle in the printing presses' eye. Through his influence the sons learned to read it too, and that's just the point—a periodical as well organized and written in language which all laymen can understand should be in the hands of the youth with a love for things mechanical. The thrill of self-education and accomplishment can go a long way toward the solution of our present and future problems. You are doing good work—keep it up.

Sincerely yours,
H. M. BRIGHTMAN
Assistant to President
Columbia Steel & Shafting Company
Pittsburgh, Pa.

SEEN and HEARD

JOHN R. GODFREY

Skull Cracker Tups

Skull cracker heads, or "tups", are usually of cast iron or steel. But one scrap yard at least uses pieces of steel that once did duty as parts of the main shafts of steam engines that have gone the way of other obsolete machinery. There are several sizes of these tups in use by the Alamo Iron Works in San Antonio, Texas, and are selected according to the size and character of the scrap to be broken up. They also use several sizes of cast tups. The wear or damage to these tups is more rapid than might be imagined and replacement is frequently necessary.

Taxes by the Hour

The Old Man was walking through the shop one day when one of his best lathe hands, Sam, said, "I've been reading a lot about the high taxes that everybody is supposed to be paying in this country and I was just wondering how much our company pays to the government."

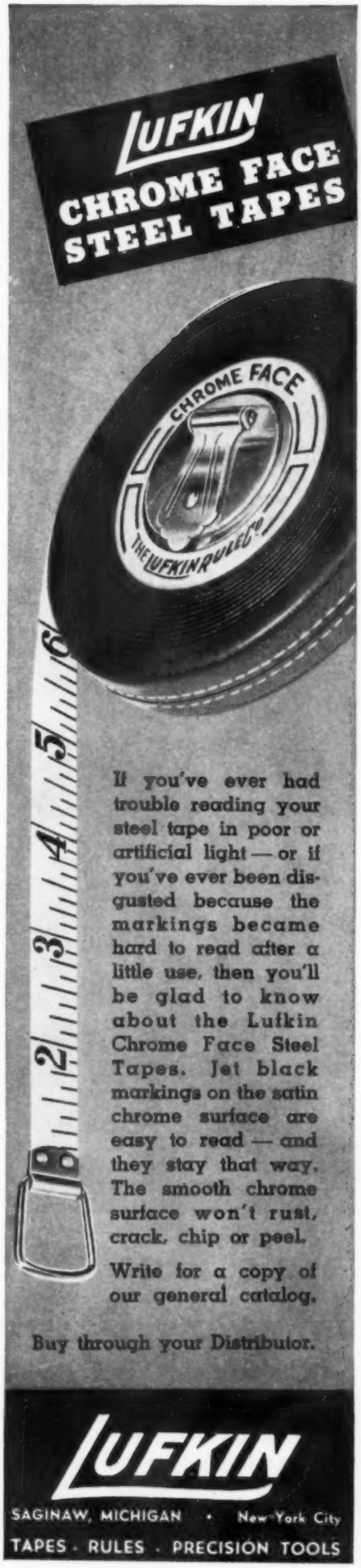
"Well, I don't know exactly Sam, but I think we pay about one quarter of a million dollars a year," said the Old Man. "I'll look it up for you and give you more exact figures tomorrow."

The next day he told Sam that the actual amount of taxes paid last year by the company had been 23 cents for every hour worked by each employee.

"You mean to tell me that for every hour you pay me the government gets 23 cents? If that is the case we ought to do something about it."

Low Powered Shop

One of the best ways of realizing the small amount of power used in machine shops 50 years ago, is to use the automobile as a yardstick. It was common for a three or four story shop, employing from 50 to 60 men, to be driven by a 25-hp. engine, usually in the basement. How much of this power was used up in belts and line shafting is anybody's guess. Now the cars the men drive to work have over three times this power under the hood.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CHROME FACE
STEEL TAPES
CHROME FACE
THE LUFKIN RULE Co.
If you've ever had trouble reading your steel tape in poor or artificial light — or if you've ever been disgusted because the markings became hard to read after a little use, then you'll be glad to know about the Lufkin Chrome Face Steel Tapes. Jet black markings on the satin chrome surface are easy to read — and they stay that way. The smooth chrome surface won't rust, crack, chip or peel.
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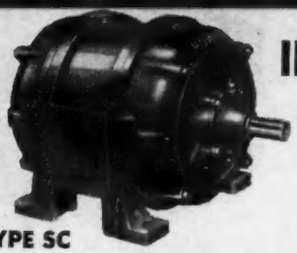


TYPE SC

TYPE K

INDUSTRIAL TYPE MOTORS
. . . A COMPLETE LINE

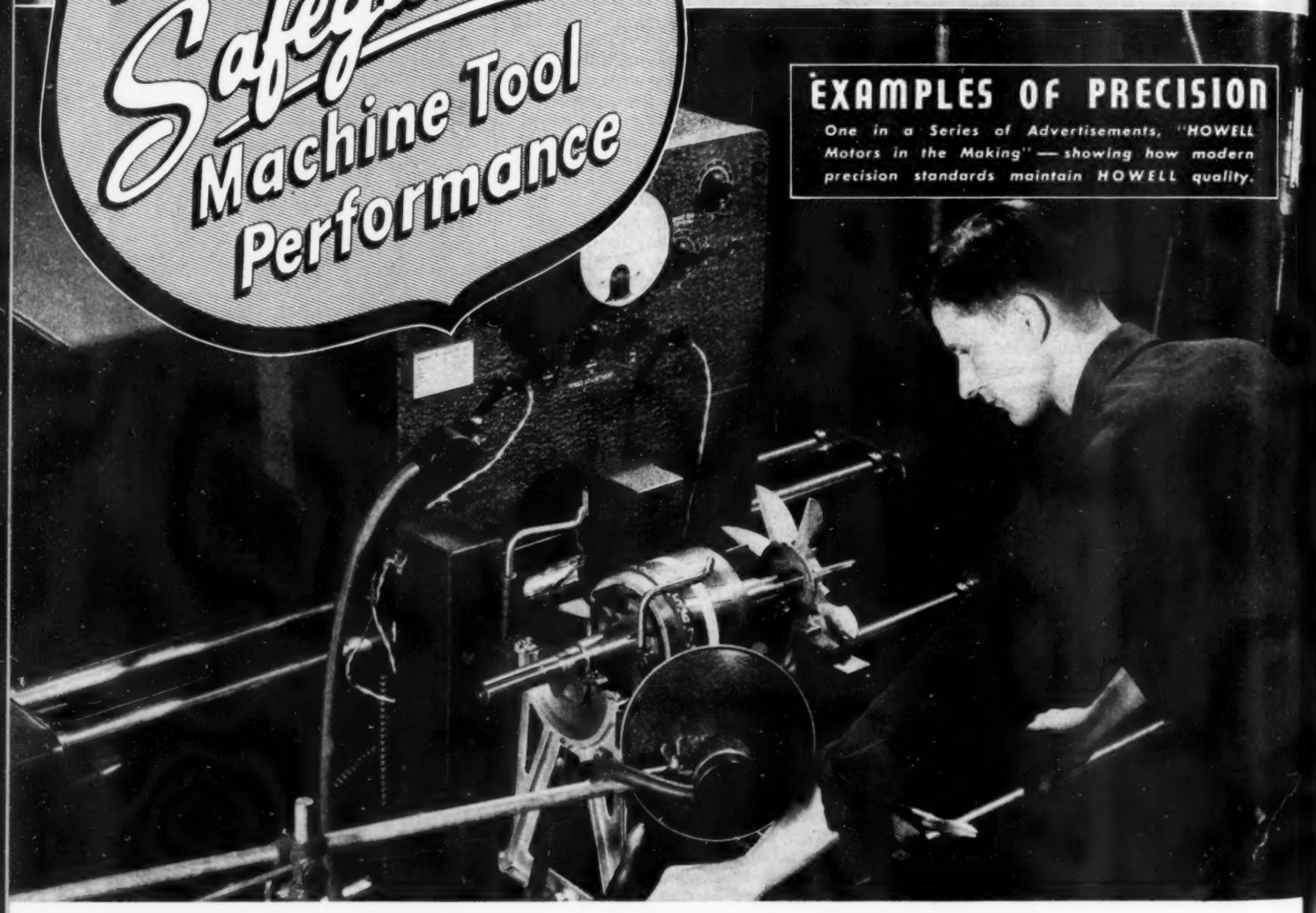
For 25 years HOWELL has specialized on polyphase motors for industrial drives. We build these motors with any electrical and mechanical characteristics required, in sizes ½ to 150 HP.

STANDARD OPEN TYPE MOTORS, **Type SC, are recommended for normal service conditions — furnished with either sleeve or ball bearings.**

TOTALLY-ENCLOSED, FAN-COOLED MOTORS, **Type K with ball bearings, are widely used where dusts, fumes or moisture make ordinary open motors short lived. Totally-enclosed feature protects all working parts. Fan cooling prevents overheating in the most strenuous service.**

EXAMPLES OF PRECISION

One in a Series of Advertisements, "HOWELL Motors in the Making" — showing how modern precision standards maintain HOWELL quality.



Here's Our PRECISION METHOD of Eliminating Destructive Vibration

A static balance of the rotor is not good enough at HOWELL! We subject every rotor assembly to a DYNAMIC BALANCE TEST, using the most sensitive testing equipment obtainable. Testing procedure is shown above. Each rotor assembly is operated at approximately the rated speed of the completed motor — the stroboglow lamp showing exact location of unbalance — the electronically operated meter indicating amount of unbalance. Correction for balance is made possible by this accurate information.

The precision-balanced HOWELL rotor assembly SAFEGUARDS your machine tool performance by eliminating drive vibration. It also insures longer motor bearing life.

Fast Delivery!

Your motor requirements — are they standard or special? Whatever your needs, the HOWELL organization is sufficiently flexible to meet them EXACTLY, and on time. Write us today, outlining your particular drive problem!

HOWELL ELECTRIC MOTORS COMPANY

HOWELL MICHIGAN . . . *Representatives in All Principal Cities*